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Proceedings

Thirty-seventh Annual Western Forest Insect Work Conference

Victoria, British Columbia

March 3-6, 1986

PROCEEDINGS

THIRTY-SEVENTH ANNUAL WESTERN FOREST INSECT WORK CONFERENCE

VICTORIA, BRITISH COLUMBIA

MARCH 3 - 6, 1986

Not for Citation
(For information of Conference Members Only)

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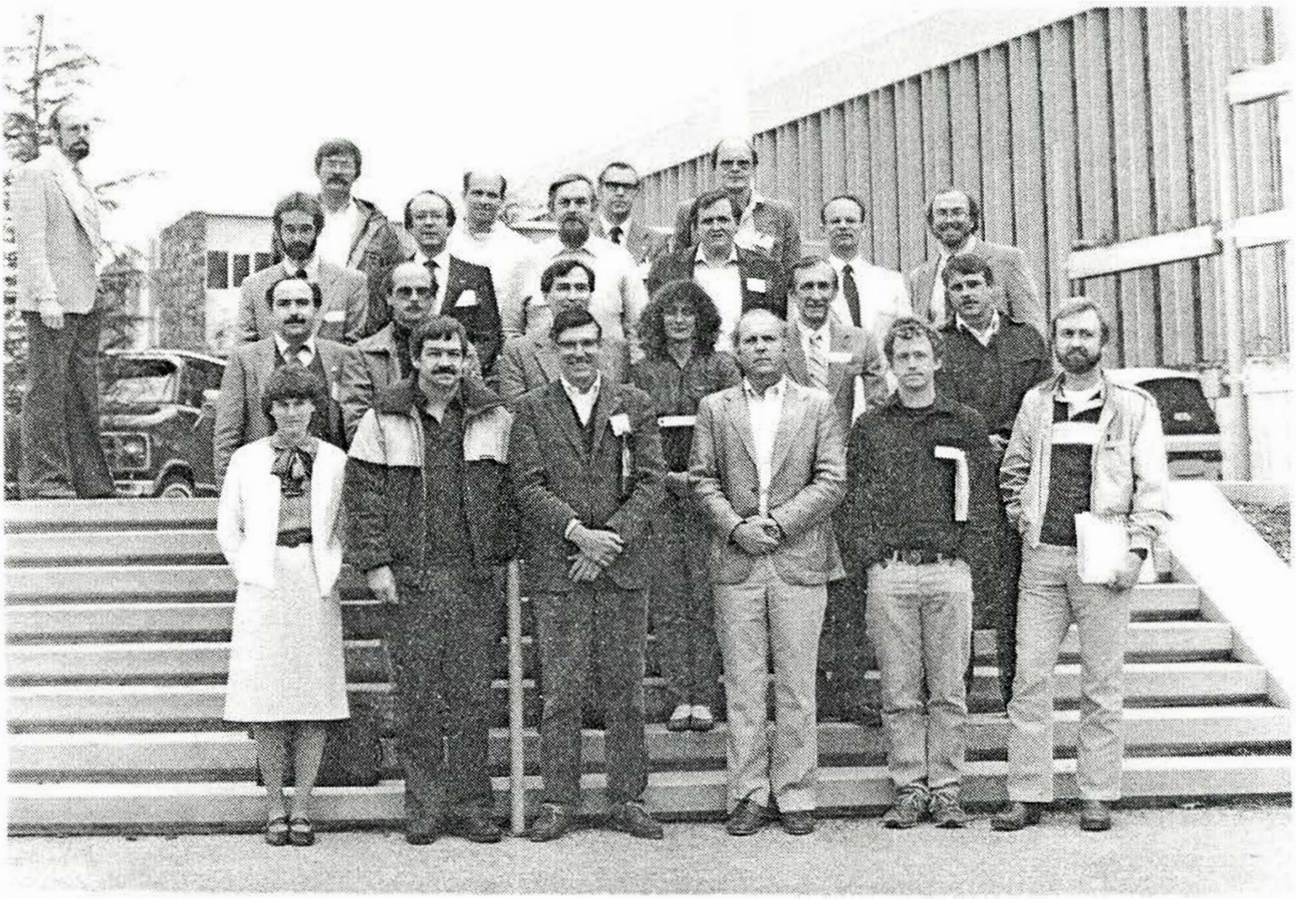
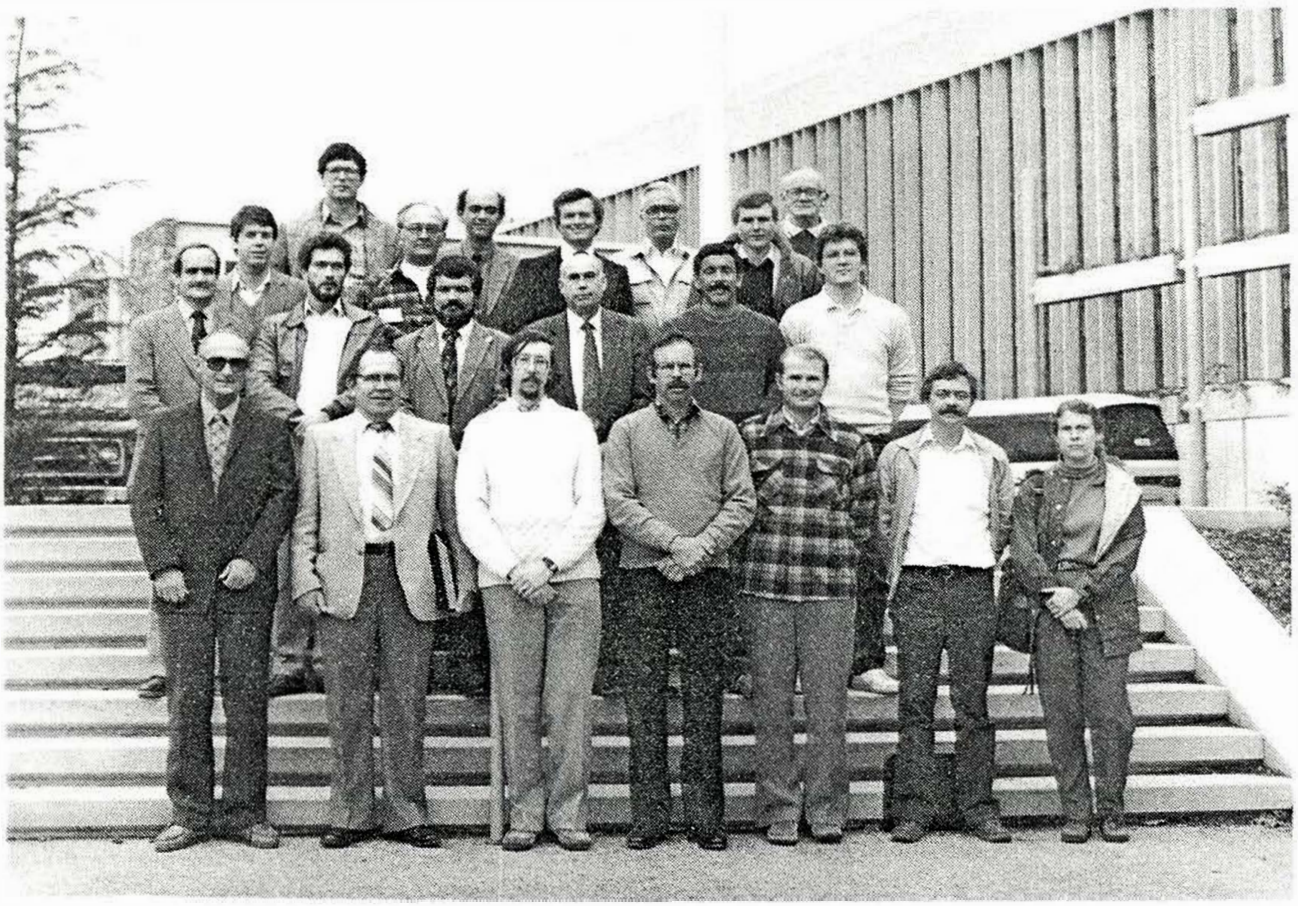
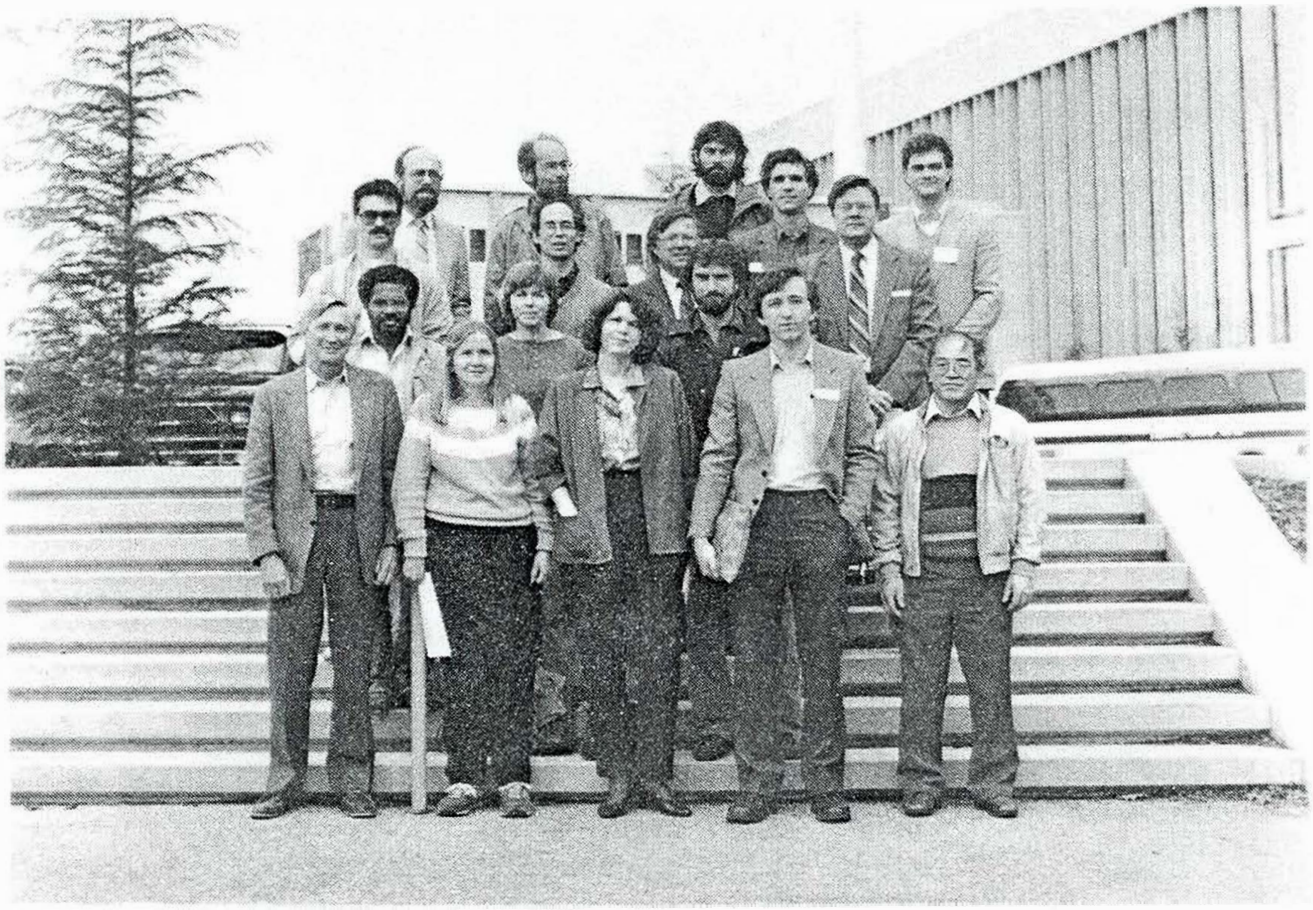


Front Row, L-R: Shân Krannitz, Don Doidge, John Foltz, Bill White, Jay Sexton. Second Row: Rene Alfaro, Peter Hall, Tom Hofacker, Iral Ragenovich, George Evans, Ed Holsten. Third Row: William Kemp, Russ Cozens, Henry Moeck, Mike Wagner, John Borden, Stephen Cook. Back Row: Ralph Thier, Dave Holland, Allan Van Sickle, Staffan Lindgren.

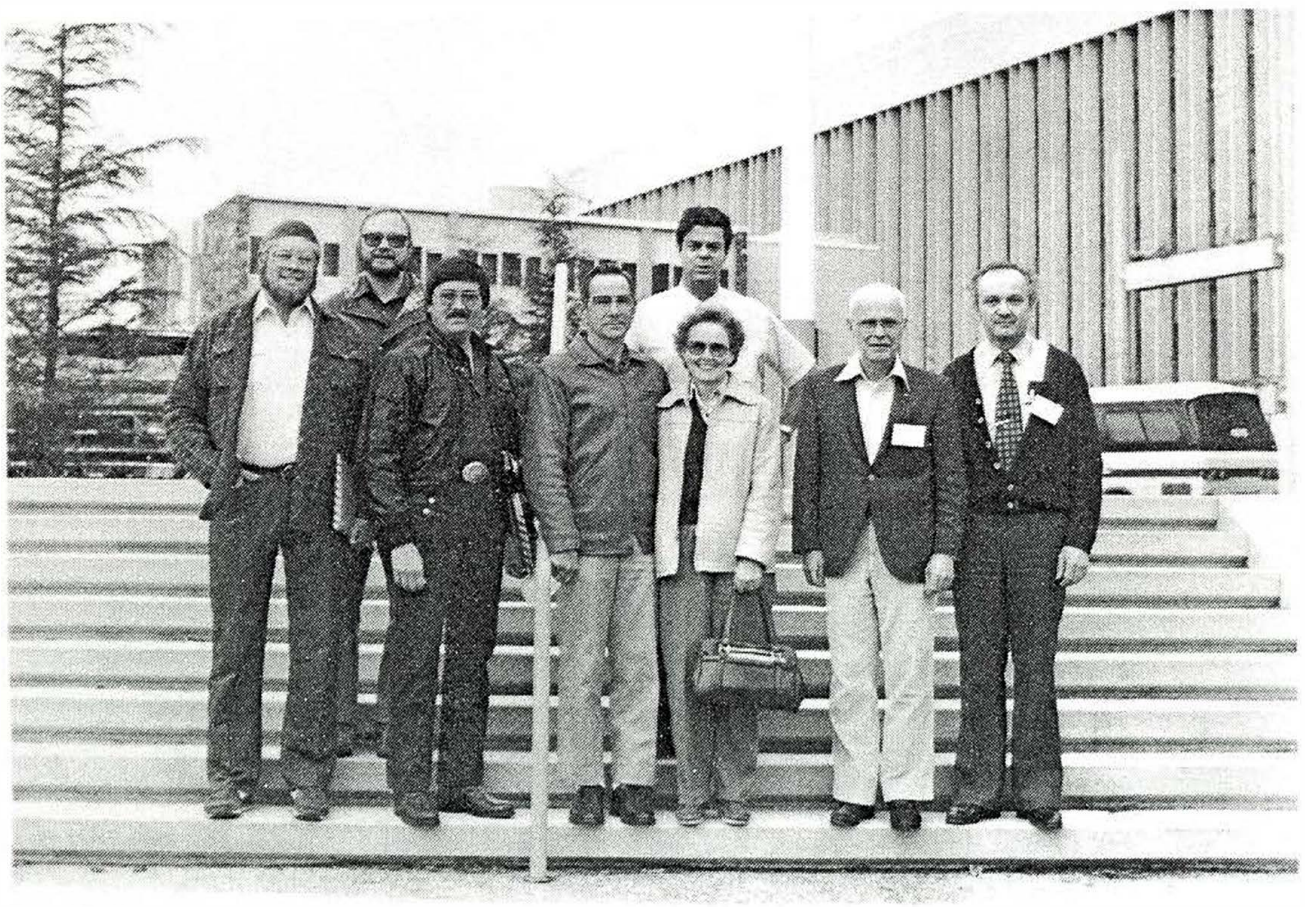
Front Row, L-R: Wyman Schmidt, Rick Johnsey, Fred Hain, Hector Richmond, Ralph Hall. Middle Row: Jeff Corneil, John Laut, Ben Moody, Peter Lorio, John Dale, Tom Swetnam, Ann Lynch, Tom Payne. Back Row: Dave Overhulser, Nick Crookston, Les Safranyik, Bob Stevens, Terry Shore, Tim McConnell.



Front Row, L-R: Dick Washburn, Les McMullen, Alan Thomson, Ron Billings, Scott Cameron, Don Summers, Jill Lownsbery. Middle Row: Don Scott, Gary Daterman, John Wenz, C.J. DeMars, Mike Jenkins, Gerry Fraser. Back Row: Tom Phillips, Al Stage, Dave Nielsen, Dan Miller, Don Owen, Bill Waters, Dick Heath, Ron Stark.



Front Row, L-R: Bill Bedard, Laura Merrill, Eveline Stokkink, Dave Hunt, Bob Miyagawa. Second Row: Phille Daur, Nancy Rappaport, Dan Clair. Third Row: David Gray, Bill Schaupp, David Wood, Forrest Oliveria. Back Row: Gordon Miller, Erik Christiansen, Joseph Fox, Steve Burke, Geoff Cushon.



PROCEEDINGS

THIRTY-SEVENTH ANNUAL WESTERN FOREST INSECT WORK CONFERENCE

VICTORIA, BRITISH COLUMBIA

MARCH 3-6, 1986

Executive Committee (Thirty-Seventh WFIWC)

J. McLean, Vancouver, B.C.	Chairperson
R. Stark, Moscow, ID	Immediate Past Chairperson
B. Moody, Edmonton, AB	Secretary-Treasurer
P. Hall, Victoria, B.C.	Councilor (1983)
N. Crookston, Moscow, ID	Councilor (1984)
D. Overhulser, Salem, OR	Councilor (1985)
G. Miller	Program Co-chairperson
P. Hall	Program Co-chairperson
A. Van Sickle	Local arrangements Chairperson

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PROGRAM FOR 1986 WFIWC

Meeting Dates: March 3,4,5,6, 1986

Location: Empress Hotel, Victoria, B. C.

Monday, March 3rd

13:00 - 19:00 Registration

19:00 - 21:00 Wine and Cheese - Duke of Kent Room

Tuesday, March 4th

08:30 Initial business meeting

09:30 Panel discussion: Site/Tree/Insect Interactions

Moderator: R. Stark

Panelists: P. Lorio
B. Wellington
W. Mattson
W. Schmidt

10:00 Coffee

10:20 Panel continues

12:00 Lunch

13:15 Workshop Session I: Site/Tree/Insect Interactions

1) Tree interactions with bark beetles - moderator S. Werner
2) Habitats and outbreaks - moderator B. Gara
3) Tree interactions with defoliators - moderator M. Wagner
4) Insect response to silvicultural treatments - moderator J. Laut
5) Site factors and bio-control - moderator R. Stark

15:00 Coffee

15:20 Workshop Session II: Various topics

1) Graduate student topics - moderator J. McLean
2) Driving forces in population dynamics - moderator R. Coulson
3) Benefits and problems with quarantines - moderator A. Van Sickle
4) Modelling - moderator H. Barclay
5) Measuring growth loss - moderator R. Alfaro

17:00 Adjourn

Wednesday, March 5th

08:30 Workshop Session III: Methodology I

1) Rearing parasitoids and predators - moderator H. Moeck
2) Experimental design and statistical analysis - moderator Errico, Bergerud, Fletcher
3) Calibrating pheromones for detection - moderator S. Lindgren
4) Toxicology - moderator J. Robertson
5) Relating weather/climate effects to population changes - moderator A. Thompson

10:00 Coffee

10:20 Workshop Session IV: Methodology II

1) Conducting insect surveys - moderator T. Shore
2) Rearing phytophagous insects - moderator D. Scott
3) Assessing pheromone control efficacy - moderator J. Borden
4) Estimating mortality rates in wild populations - moderator B. Moody
5) Including uncertainty in simulation models - moderator N. Crookston

12:00 Lunch

13:00 Travel to PFC

13:30 Welcome to PFC - Ross Macdonald

13:45 Panel discussion: Technology Transfer and Identifying Problems Requiring Research

Moderator: R.F. DeBoo

Panelists: C. Edwards, CFS
D. Wood, University
R. Cozens, M.O.F.
D. Graham, USDA Forest Service

15:00 Coffee

15:20 Tour of new facilities at PFC and technique workshops. Space can be arranged for those wishing to hold their own meetings (organizers: T. Shore and R. Alfaro - see attachment)

16:30: Back to Empress

18:30 Crystal Gardens - Buffet and No Host Bar.
Buffet served at 19:30.

Thursday, March 6th

08:30 Workshop session V: Assessment of current work and subject areas for future research.

1) Bark beetles (esp. hazard rating) - moderator G. Amman
2) Cone and seed insects - moderator M. Haverty
3) Nurseries and plantations - moderator D. Overhaulser
4) Defoliators - moderator J. Sweeney
5) Insect dispersal - moderator D. Schmitz

10:00 Coffee

11:00 Final business meeting

12:00 Lunch

13:15 Panel discussion: Feasibility of Direct Control (Bark Beetles and Defoliators)

Moderator: P. Hall

Panelists: R. Couzens, M.O.F.
J. Churcher, Ontario MNR
M. Hulme, CFS
D. Holland, USDA Forest Service

15:00 Coffee

15:20 Workshop Session VI: Control Techniques

1) Biological control using parasites and predators - moderator I. Otvos
2) Chemical control - defoliators - moderator R. Johnsey
3) Chemical control - bark beetles - moderator P. Shea
4) Bt. and pathogens - defoliators - moderator J. Churcher
5) Behaviour modifying chemicals for bark beetles - moderator K. Gibson

16:30 Adjourn

WFIWC Technique Workshops
Canadian Forestry Service
Pacific Forestry Centre

Wednesday, March 5, 1986 3:20 - 4:30 p.m.
Organizers: Terry Shore and Rene Alfaro

Program: Following the afternoon panel discussion being held at Pacific Forestry Centre there will be a little over an hour for visitors to either take a general tour of the facilities at PFC or to drop into one or more of the "technique workshops". These workshops will consist of a display or demonstration on the following topics and informal discussion amongst the attendees. The attached map shows the locations of the workshops.

WORKSHOPS

Workshop 1.
Title: General Tour of Pacific Forestry Centre
Presenter: Elaine Teske
Room #: Meet in ground floor lobby at 3:20
Description: A general guided tour of the facilties at PFC.

Workshop 2.
Title: Electrifying Smells
Presenter: Tom Gray
Room #: 206
Description: A display and demonstration of equipment, including gas-analyzer and electro-antennagram, currently being utilized at PFC to isolate and identify behaviour modifying chemicals. Discussion of technique, problems, and field tests involving Choristoneura spp., Zeiraphera improbana and Actebia fennica.

Workshop 3.
Title: Pest Impacts
Presenter: Rene Alfaro
Room: 384
Description: A discussion and demonstration of techniques and computer software for tree ring measurement and for growth loss calculations.

Workshop 4.
Title: Destructive Bark Beetles
Presenters: Les Safranyik and Terry Shore
Room: 173
Description: A panel display and discussion of major bark beetles in B.C. with emphasis on the Mountain Pine Beetle. Topics presented include life history, population biology, damage, management and research.

Workshop 5
Title: Biological Image Processing
Presenters: Tara Sahota and Fred Peet
Room #: 181
Description: Use of a computer, microscope and television camera together with the techniques of pattern recognition, for studying images of biological material related to forestry.

Workshop 6
Title: Remote Sensing
Presenter: Jim Lee
Room #: 185
Description: Computer analysis of satellite and aerial photographs for forestry.

Workshop 7
Title: Light and Electron Microscopy
Presenter: Lesley Manning
Room #: 154
Description: Magnifications of up to one million times life size aid in many areas of forestry research.

Workshop 8
Title: Insectary
Presenter: Lee Humble
Room #: 364
Description: The processing, rearing and identification of survey samples and the forest insect data bank will be discussed. Data bank includes detailed information on approximately 160,000 collections of forest insects made since 1949. A separate data file of about 10,000 entries details parasitoid-host associations from the collection records.

Workshop 9
Title: "Overlay" computer mapping and analysis system
Presenter: Alan Van Sickle
Room #: 379
Description: Demonstration of a data base management and mapping system used by the Forest Insect and Disease Survey. System capability varies from the detailed to the general (local to national scale) and can incorporate forest inventory data.

Workshop 10
Title: How to build a simulation model
Presenter: Alan Thomson
Room #: 266
Description: This workshop will be especially for entomologists who are unfamiliar with model development. Using mountain pine beetle as an example, the workshop will focus on the different components of a model, illustrating different approaches depending on the requirements of the study.

THIRTY-SEVENTH WESTERN FOREST INSECT WORK CONFERENCE

Minutes of the Executive Committee Meeting
Victoria, British Columbia, March 3, 1986

Chairperson McLean called the meeting to order at 8:05 p.m.

Present were:
John McLean, Chairperson
Ron Stark, Past Chairperson
Ben Moody, Secretary - Treasurer
Peter Hall, Councilor and Program Co-chairperson
Nick Crookston, Councilor
Dave Overhulser, Councilor

Absent were Program Co-chairperson Gordon Miller and local arrangements Chairperson Allan Van Sickle.

Minutes of the 1985 Executive Committee Meeting, Final Business Meeting and the Treasurer's Report were read and businesses arising were discussed.

The Nominations Committee of Ron Stark, Peter Hall and Nick Crookston was charged with finding a new chairperson and a new councilor for the position helded by Peter Hall.

The following correspondance were read and discussed:
a) Molly Stock re: used of visual aids at WFIWC
b) John Schmid re: possible USFS constraints
c) Max McFadden - change of name to change perception of WFIWC as just another meeting
d) ex Bucham re: WFIWC and attendance of US personnel
e) Stark/Abraham re: WFIWC Archives
f) Foltz re: 1986 meeting of the SFIWC
g) Common Names Committee - Torgerson re: western tussock moth, Orgyia cana name change

Nick Crookson questioned the fact that the mailing list was not included in the Proceedings. The Secretary reported that the 1985 attendants mailing list was not available at time of printing.

It was recommended that the History Committee be reimbursed by the WFIWC for expenses incurved such as postage cost of $200. Ron Stark suggested a .50¢ fee surcharge on Registration to support the History Committee. Ron was asked to supply a budget and that the WFIWC would support the History Committee to the sum of $200 US.

Chairperson McLean was to call for a venue for the 1988 WFIWC.

The Ethical Practices Award was discussed at length and it was decided to put to the WFIWC membership a resolution to do away with the practice. It was suggested that Dave Holland be asked to provide a requiem.

List of deaths Beal and Terrell; and awards Borden, Coulson, and McGregor were made for announcement at the Initial Business Meeting.

Peter Hall mentioned that there was an obvious lack of Displays at the WFIWC. He felt that it was important to know what new technology is available. It was agreed that there should be no charge for display space and that the majority of the membership were against commercialism, but that members should be exposed to new technology. Should include in the WFIWC Bylaws that commercial organisations be responsible for space, expenses, etc. and that a study be conducted into the matter. It was suggested that a committee be formed to study the issue of displays.

The meeting was adjourned at 9:45 p.m.

THIRTY-SEVENTH WESTERN FOREST INSECT WORK CONFERENCE

Minutes of the Initial Business Meeting
Victoria, British Columbia, March 4, 1986

Chairperson McLean called the meeting to order at 8:30 a.m. and welcomed members to beautiful Victoria, British Columbia.

Tribute was made by the membership to deceased members James A. Beal and Ian Terrell.

Minutes of the 1985 Final Business Meeting and the Treasurer's Report were read and approved.

The Chairperson's Report was read and accepted.

Special awards received during the 1985-86 by Mark McGregor, John Borden and Robert Coulson were mentioned.

Ron Stark reported on the History Committee, and specific projects for 1986-87 were; to collect historial records for the archives, to actively search for historical publications, and to identify relevant on-going historial projects.

The membership was informed by a letter from Tony Torgersen, Chairperson of Common Names Committee, of a proposed name change: that the "western tussock moth" is Orgyia cana and that the diminutive O. vetusta need no common name at this time.

Notice of Motion was made to change the name of the Western Forest Insect Work Conference to the Western Forest Insect Workshop as the word "conference" tended to impede travel fund approval. The membership was requested to consider this motion and vote at the Final Business Meeting.

The following Committees were formed for the Meeting and were to report to the Final Business Meeting:

a) Ethical Practices Committee - Dave Holland
b) Commercial Displays/Sponsorship - Peter Hall
c) Resolutions - Dave Overhulser
d) Nominations Committee - Ron Stark

Members were invited by John Foltz to attend the Southern Forest Insect Work Conference at Nashville, Tennessee on August 12-14, 1986.

Chairperson McLean called for suggestions for the 1988 WFIWC Meeting.

Local arrangement chairperson, Allan Van Sickle called for completion of forms for updating mailing list.

The meeting was adjourned at 9:15 a.m.

TREASURER'S REPORT

Thirty-seventh Western Forest Insect Work Conference
Victoria, British Columbia, March 3, 1986

Balance on hand March 7, 1985	(+)	$ 2,769.68 U.S.
Expenses:		
Nursery tours, Colorado (additional cost)	(-)	54.20
Hotel deposit for 1987 WFIWC	(-)	500.00
Advance for 1986 WFIWC, Victoria	(-)	148.00
Printing of 1985 Proceedings	(-)	503.00
Income:		
Sale of commemorative coffee mugs	(+)	50.00
Interest	(+)	90.00
Balance on hand March 3, 1986	(+)	$ 1,758.69 U.S.

CHAIRMAN'S REPORT

TO THE 37TH ANNUAL MEETING OF THE WESTERN FOREST INSECT WORK CONFERENCE

VICTORIA, BRITISH COLUMBIA MARCH 4, 1986

Nothing is more certain over time than change. Everyone is another year older and this year that small factor has led to a large number of retirements. The retirement of esteemed colleagues reminds us that Institutions are around for a long time but that people pass through in a shorter time frame. In an effort not to lose those things that are unique about the entomologists and the practice of forest entomology in western North America, your current past-Chairman, Ron Stark, and his History Committee have been very busy setting up the procedures for archiving the historical record of the Western Forest Insect Work Conference at the University of Idaho. You will note that Ron will be giving us a full report this morning and I urge you all to participate fully with his committee.

The CANUSA programs have been producing their documents during this last year. Although there is joint Canada-USA Lodgepole pine/Mountain pine beetle project at this time, the numbers of active forest entomologists in the Western United States seem to be declining. In British Columbia, on the other hand, we have seen sustained activity over the last year. The Federal laboratory on Burnside Road has opened a new wing and we will have the opportunity to tour it on Wednesday afternoon. The Pest Management Branch of the B.C. Forest Service has continued its battle with the spruce beetle and the mountain pine beetle. Interior forest companies in particular have many of their cutting permits issued to deal with beetle salvage or sanitation cuts. Many timber supply areas have seen their annual allowable cuts temporarily raised so that a maximum of the beetle wood can be salvaged. The industry has the capacity to deal with it but the huge volumes of lumber coming on to the North American markets have resulted in counter-activities of a political kind. Many of you are well aware of the current push for tariffs on B.C. lumber in the United States. Did you make the entomological connection as to part of the cause for this?

Each of the six forest regions in British Columbia now has a Pest Management Coordinator and a Forest Entomologist on staff (five of the regions also have a Pathologist position). This is a great improvement from just 6 years ago when there was no-one at regional level to deal with pest management concerns. It is my understanding that many of these regional entomologists and at least one of the

regional pest management coordinators will be at the meeting and will be giving us the benefit of their experiences. Last year I remember speaking with several young foresters who were involved with the Front Range Project in Colorado. I certainly enjoyed that opportunity to hear how they managed for mountain pine beetle. I hope that at this meeting you will be able to hear how things are being done in B.C. and to raise all the questions you can think of.

Bark beetles are not the only concern of forest entomologists in British Columbia. You will see many of the current activities of the Pacific Forestry Centre on Wednesday. In addition there is a new $300 million dollar federal/provincial Forest Regional Development Agreement (FRDA) in British Columbia. The major emphasis in this agreement is to address the problems of backlog reforestation and no doubt the forest entomologists will need to be out there helping to protect this multimillion dollar investment as the new seedlings are set out in the cutover areas.

Our members continue to be recognized for their special efforts in forest entomology.

Mark MacGregor was one of only three individuals in the Northern Region of the USDA Forest Service (which has approximately 1750 employees) to receive the 1985 Regional Forester's Honor Award. Mark was recognized for his outstanding contributions in technology transfer and overall bark beetle management efforts. Congratulations Mark.

John Borden, at Simon Fraser University, was awarded the 1985 Gold Medal Award in the Natural Sciences by the Science Council of British Columbia. John was recognized for his ongoing basic and applied research on the semiochemicals of bark and ambrosia beetles and for the way he has encouraged the transfer of the technology to the private sector and so help a pest management company become established in B.C. Congratulations John.

We have been fortunate to have Robert Coulson as a welcome member from the Southern Forest Insect Work Conference in recent years. I am sure that you would like me to acknowledge the fact that he was the 1985 recipient of the J.E. Bussart Memorial Award of the Entomological Society of America for outstanding contributions in applied entomology. Congratulations Robert.

We are in good shape when we have these talented members to share with us the challenges that we are presented with today in forest entomology. This meeting provides a valuable forum wherein we can exchange news and views. One of the more important features of these conferences is the workshop format where everyone is encouraged to participate. I personally, from the time that I was a graduate student up to the present, have found the members to be encouraging and helpful. To graduate students

I say don't be afraid of these eminent scientists you know only from published works. Search them out and talk to them, over a beer, over lunch or on the jogging trail- they are committed professionals with their own point of view. They are only to happy to tell someone about it and invariably they will also be most interested to hear about what you are doing.

I personally look forward to this afternoon's session for Graduate students. Please take time to come along and tell us how we can make your experience in graduate school more meaningful for you. What would you like to see more of? What would you like to see less of? What do you think your Professors should do for you? What do you think you do for them? The session will be summarized and written up in the proceedings of the Conference. I look forward to seeing you and hearing your opinions.

In closing, I would like to thank the present executive for their assistance throughout the year. When assistance was sought, it was freely given. A full program has been arranged for you by Gordon Miller and retiring Councilor Peter Hall, your program chairmen. I wish you all an enjoyable conference, happy and frank discussions and an pleasant stay in Victoria.

John McLean
March 4 1986

PANEL: SITE/TREE/INSECT INTERACTIONS

Moderator: Ron Stark

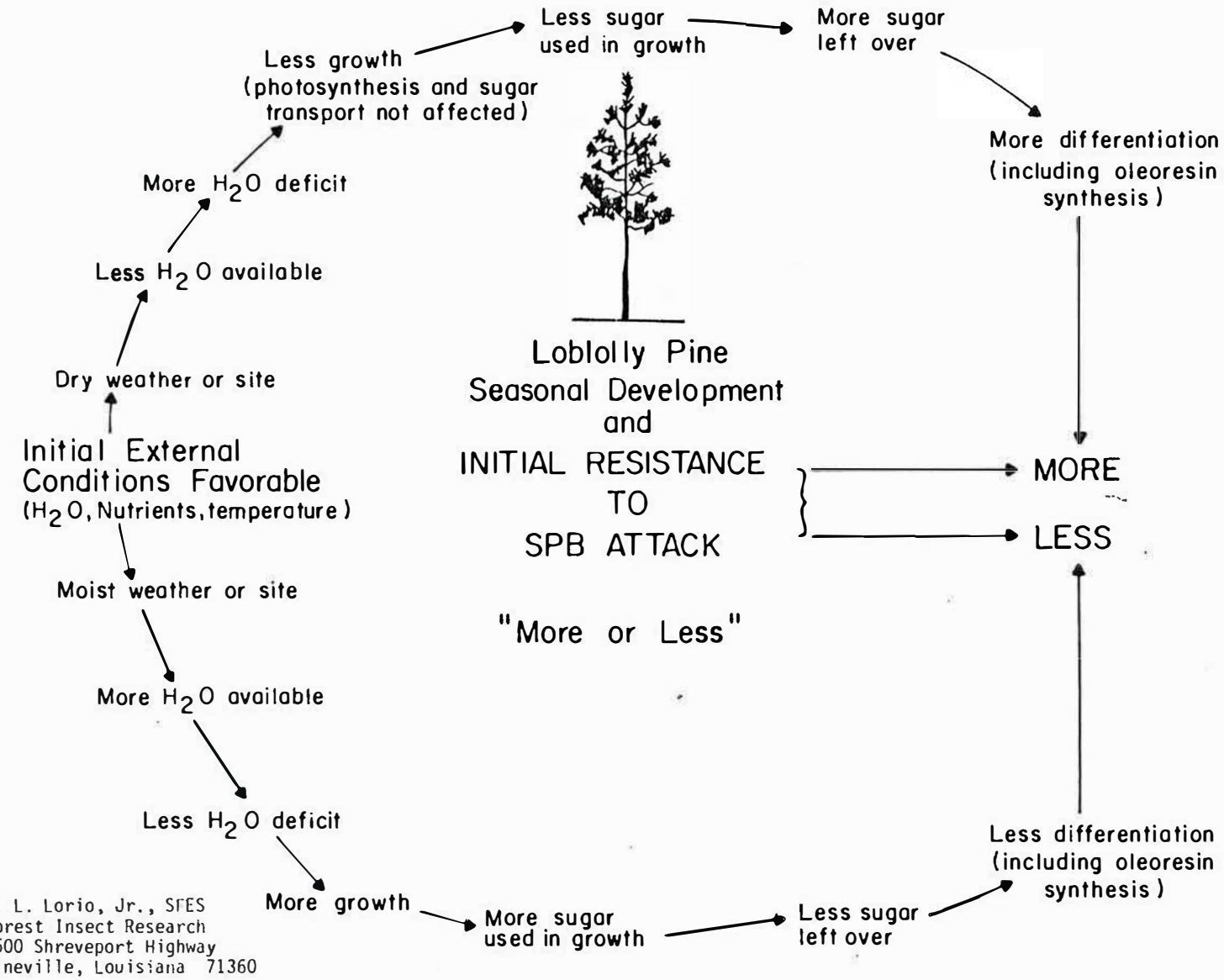
Panelists: Bill Wellington, Pete Lorio and Wyman Schmidt

Three views of the interactions of site, trees occupying the site, and forest insect activity were presented. Unfortunately, Bill Mattson was unable to attend, thus depriving us of an update of his work since his and Addys' classical Science paper of 1975 (186:645-647).

The following summaries were prepared by the panelists, and although the approaches and emphases varied, linking them should not be difficult. The growth and differentiation processes described by Lorio are obviously strongly influenced by site and regional climate discussed by Wellington and stand factors described by Schmidt. I have not tampered with any of the summaries, but am compelled to report on Bill Wellington's castigation of our neglect of weather and climate in our ecological research. I remind one and all of the importance of "weather" in all our endeavors and admonish you to look up from your binoculars and branches to the sky once in awhile.

Physical conditions on a site often affect the biological interactions between the insects and the trees living there. But in hilly terrain, "site climates" are determined more by the nature of the surrounding topography than by the purely local situations. Where ridges generate day-time clouds repeatedly, the resulting diurnal patchwork of clear and cloudy skies creates climatic mosaics over the affected slopes and adjacent valleys. For example, two contiguous valley sites with similar aspects, slopes, drainages and soil types may still differ significantly in the annual amounts and frequencies of precipitation and solar heat they receive, simply because one is in the path of the series of clouds that repeatedly drift over it from a distant ridge, whereas the other lies just outside that cloud-line's boundary. These temperature and moisture differences between the two sites ultimately will be reflected in the behavior, development and survival of the local populations of insects, and these differences in turn will affect the health and composition of the plant communities growing there. Because of its highly predictable effects on local populations of trees and insects, we must take into account terrain modification of regional weather in any pest-management program designed to exploit site/tree/insect interactions.

Walter E. Loomis' concept of Growth-Differentiation Balance was introduced, explained, and recommended as a useful basis for understanding bark beetle/tree interactions. Application of this concept to Dendroctonus frontalis/Pinus taeda L. relationships provides a rationale for explaining commonly observed phenomena heretofore difficult to understand. Early in the growing season conditions are commonly favorable for growth and normal ontogeny of trees results in high demands (sinks) for available energy (CHO), leaving little opportunity for synthesis of defensive chemicals (oleoresins), products of differentiation. Moderate seasonal water deficits reduce the potential for growth and enhance the potential for oleoresin synthesis. Recognition of such normal changes in host physiology through growing seasons helps explain how apparently healthy, vigorously growing trees vary in their resistance to bark beetle attack and, at times, may be


Less sugar used in growth
More sugar left over
Less growth (photosynthesis and sugar transport not affected)
More differentiation (including oleoresin synthesis)
More H_2O deficit
Less H_2O available
Loblolly Pine Seasonal Development and INITIAL RESISTANCE TO SPB ATTACK
"More or Less"
MORE
LESS
Dry weather or site
Initial External Conditions Favorable (H_2O, Nutrients, temperature)
Moist weather or site
More H_2O available
Less H_2O deficit
More growth
More sugar used in growth
Less sugar left over
Less differentiation (including oleoresin synthesis)

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quite susceptible to attack (Fig. 1). Growth response alone is an unreliable indicator of "vigor," or resistance to bark beetle attack.

Reducing susceptibility and vulnerability of forests to insects with silviculture is based on the premise that forest conditions supporting problem insects can be altered to make them less favorable for the insect and more favorable for the trees. Western spruce budworm and their host trees are a good case in point.

Two factors--effective fire control and economic selection cuttings for much of this century in the northern Rockies--have accelerated succession toward more climax forests. Climax species such as Douglas-fir and the true firs are the primary feeding hosts of budworm. The challenge to the silviculturist lies in reversing these successional trends. A number of silvicultural practices are available to accomplish this including even-age regeneration cutting systems for mature forests and thinning for immature forests. These practices can adjust species composition, stand structure, stand density, vigor and age--all important factors in reducing susceptibility to western spruce budworm. Fortunately, nearly all of the silvicultural practices needed to reduce the budworm problem are the same as those needed to manage the forests on sound ecological principles.

WORKSHOP: TREE INTERACTIONS WITH BARK BEETLES

Moderator: Skeeter Werner

Participants: Eric Christiansen, Steve Cook, Fred Hain, Felton Hastings, Pete Lorio, Henry Moeck, Tim Paine, Les Safranyik, Terry Shore

Host resistance to various Dendroctonus bark beetles was discussed. Current research is based on several different viewpoints. The Growth-Differentiation Balance Concept is being applied to the study of resistance of loblolly pine to southern pine beetle in Louisiana. Changes in oleoresin flow in relation to radial growth shows significance to the relative susceptibility of trees to southern pine beetle. The relation of oleoresin flow and tree wounding and Ceratocystis minor to host resistance to southern pine beetle is being investigated in loblolly and short-leaf pine in North Carolina. Resistance in loblolly pine to southern pine beetle in Arkansas is centered on the induction of plant defenses by wounding and by fertilization. Host resistance of white spruce, Sitka spruce, and Lutz spruce to spruce beetle is underway in south-central Alaska. Cold soils cause moisture deficits during periods of beetle flight and attack in early spring, and result in reduced tree vigor and radial growth. Host susceptibility of white spruce to spruce beetle in British Columbia was correlated to ethanol production in wound tissue which attracted spruce beetles. The resistance of Norway spruce to attack by Ips typographus in Norway is related to tree vigor which increases the defensive capability of spruce by increased primary resin within newly formed resin ducts.

Workshop: Tree interactions with defoliators

Moderator: Mike Wagner

Participants: Approximately 25 people representing broad geographic and interest areas attended this workshop

The focus of the workshop was to identify some of the broad patterns of interactions between site, trees, and insects. Once a few important patterns were identified the group attempted to identify important mechanisms responsible for the observed patterns. Finally the participants discussed some research protocols that they felt should be applied to test some of the mechanisms identified.

Bill Kemp began the discussion by summarizing his recent publication on regional climatic patterns and western spruce budworm outbreaks (Kemp et al. 1985. Spruce Budworm Handbook 1693). Bill and colleagues found predictable patterns of outbreaks based on two factors: water and nutrient deficiency. Most participants agreed that these two site factors are commonly associated with insect outbreaks in a variety of areas and for several species. Some members of the group were quick to point out that though water and nutrient stress often leads to insect outbreaks there are clearly exceptions worthy of note.

Once the group identified water and nutrient stress as potential important factors we attempted to list all the possible mechanisms. To explain why a water stressed tree could result in increased populations of a forest insect the group suggested the following possible mechanisms: 1) stressed trees have higher surface temperature that increases insect development rate 2) stressed trees have lower defensive chemicals 3) stressed trees have thicker cuticles that slow feeding 4) stressed trees increase in nitrogen that is often limiting to insects 5) stress in trees influences predators or parasites that affect the herbivore population (3 trophic level effect) 6) stress affects mycorrhiza 7) stress affects induced resistance mechanism in trees. Mechanisms that could affect nutrition level of the host included: 1) lower phosphorus 2) nitrogen (as above) and 3) changes in the balance of major nutrients. The group made no effort to suggest which of the above mechanisms would most likely be important.

Finally the workshop participants discussed important research protocols that should be considered when attempting to test mechanisms. Important factors that should be considered include: 1) correct development stage of the insect-preference for complete generation bioassays 2) separating genetic vs environmental contributions 3) appropriate temporal considerations - How much stress for how long? etc. 4) appropriate spatial considerations in locating study sites 5) placing emphasis on experimental design, sample size, appropriate application of statistical methods, etc.

The workshop group felt there was much research needed to understand how site factors influence insect populations through host changes. Advances in this area will likely only occur with considerable cooperative effort among forest entomologists.

MRW:iel

WORKSHOP: SITE FACTORS AND BIOLOGICAL CONTROL

Moderator: Ron Stark

Participants: John Harris, Bill Schaupp, Eveline Stokkih, Roger Ryan, Rhonda Millikin, David Gray, Imre Otvos, Alan Stewart, Dan Clair, Nancy Rappaport, Max McFadden, John Moser, Gerhard Griese, Ralph Hall

To stimulate discussion Stark described recent work at Idaho by Chris Niwa and Richard Nathanson. Chris found that the relative efficacy of two introduced parasites varied between sites; each obviously had different requirements. Richard found that both species composition and abundance of parasites varied with elevational factors; work by Ryan indicates variations in photoperiod and temperature with elevation are important. Nathanson also found that the vertical structure of the undergrowth affected number of species and percent parasitism. Both found indications that particular plant species may be important.

Although early works (1960s-1970s) in Europe and Canada have shown the importance of vegetation and other site factors both for the establishment and effectiveness of introduced parasites even where abundant hosts are present, there has been little such work reported on biological control of forest insects. The importance of site is recognized, however. Pschorn-Walcher (Annu. Rev. Ent. 1977) emphasized the importance of site both in choice of areas for the search for candidates for introduction and in choice of release sites in biocontrol programs. Stark reported that a bibliography of world literature on parasites of the larch casebearer will soon be available from the College of Forestry, Wildlife and Range Sciences, University of Idaho. Several entries on site factors and parasitism are included.

WORKSHOP: GRADUATE STUDENT TOPICS
Moderator: John McLean
Participants: Kathy Lewis, Jay Sexton, Bob Gara, John Schenk, and Bob Stevens.

This Workshop will undoubtedly rank as the greatest non-event of the Work Conference, Graduate Students were apparently so enthused by the topics of concurrent Workshops that they were lured away from this opportunity to express any concerns that they had over the current graduate student lot.

Those present reminisced about the reasons as to why they had undertaken graduate work, mostly it was the desire to be able to carry out self-directed research. Whether Kathy and Jay were impressed with this baring of the soul by the academics we will never know.

Lack of any further recruits for the workshop by 4.10 pm resulted in the Chairman declaring it adjourned and members went to seek the stimulating comaraderie of their colleagues in 'real' workshops.

WORKSHOP BENEFITS AND PROBLEMS WITH QUARANTINES

MODERATOR Allan Van Sickle
PARTICIPANTS John Borden, Steve Burke, John Dale, Dave Graham, Mike Irvine, John Laut, Carol Lowenberger, Red McComb, Dave Overholtzer, H. Richmond, Ulf Runesson, Wyman Schmidt.

A partial listing of forest pests introduced to North America (including European pine shoot moth, Nantucket pine tip moth, gypsy moth, balsam woolly aphid, winter moth, larch casebearer, crane fly, strawberry vine weevil, poplar and willow borer, Dutch elm disease, Scleroderris canker, chestnut blight, white pine blister rust, etc.) was reviewed. Despite the substantial number of introductions it was felt that movement restrictions were very necessary, beneficial and reasonably successful. It was emphasized that a considerable level of inspection was affordable and preferable to a large scale eradication or successful introduction.

Benefits of quarantines mentioned included:
(i) delays (hopefully prevents) introductions;
(ii) allows for commodity exports to specific pest-free countries or areas;
(iii) stimulates and maintains care on behalf of importers and exporters;
(iv) problems or risks can galvanize the industry, provide public education opportunities, and with publicity improve political support for necessary research.

Recognized problems included:
(i) difficulty of convincingly quantifying benefits prior to an introduction;
(ii) drafting of regulations and adequacy and enforcement of inspections;
(iii) regulation of inter- or intra- state or province movement is even more difficult than international movement;
(iv) treatment and post-entry quarantine losses, costs and limitations;
(v) risk of regulations being abused as artificial trade barriers;
(vi) failure to enforce at the variety or strain level due to insufficient diagnostic techniques.

Specific discussion or recommendations included:
(i) California has done a thorough job of listing and priorizing its most likely imports and threats. This exercise should be cooperatively emulated by forestry and agriculture agencies.
(ii) The use of pheromones has been greatly improved and expanded for detection, but there should not be an over-reliance on them.
(iii) Increasingly, importations should be based on tissue cultures rather than cuttings.
(iv) Interagency cooperation and support of quarantine needs should be encouraged as well as a greater lead agency response. Recognition and "networking" among professionals should identify needs and inform and pressure the necessary political levels for support.
(v) Any research necessary to avoid a risk of over-regulation should be conducted promptly.

WORKSHOP: MODELLING
Moderator: Hugh Barclay
Participants: Hugh Barclay, Dale Barton, Dan Clair, John Harris, Rhonda Mather, Imre Otvos, Al Stage, Al Thomson.

A brief introduction was given by the moderator outlining one simple classification of models into (a) predictive, and (b) explanatory models. The major characteristics of these were reviewed. Briefly, predictive models rely heavily on regression methods and attempt quantitatively precise and accurate predictions of certain major features of the system, such as pest impact or volume growth. Explanatory models are more mechanistic and process oriented and attempt to explain the behavioural features of the system in terms of under-lying processes; eg. the budworm model explains the periodicity of outbreaks.

Two questions were posed for general discussion. These were: (a) Is it better to develop a very complex model, taking into account as many features of the system as possible, or is it better to keep the model reasonably simple, with few parameters to estimate? (b) Is the investigation of general system behaviour (such as stability) of any real use to the practicing entomologist? Only the first of these questions received any real discussion. Most of the participants were not modellers, and came mostly to listen, but they posed some interesting questions.

Some discussion took place on the importance of structuring model processes appropriately. It was agreed that processes in parallel yielded fewer anomalies than processes in series in models. However, where processes in nature are known to act in series, the model should reflect this.

MEASURING GROWTH LOSS

MODERATOR: Rene I. Alfaro, Pacific Forestry Centre

Our workshop discussed the problem of how to assess the damage caused by insects that, without killing the trees, result in reduction in increment. Following presentations by Tom Swetnam (Tree Ring Research Laboratory, U. of Arizona) and myself, the participants (about 30 members) engaged in active discussion.

A first item of discussion was the distinction between individual tree losses and losses at the stand level. Individual tree losses consist of losses in diameter and height growth which combine into volume growth loss. In addition, individual trees may suffer quality losses due to deformations of the stem such as those induced by top-kill.

Losses at the stand level include all those factors that cause the entire wood volume in an unit area to grow slower than expected. These include tree mortality, the sum of the growth an quality losses in individual trees and any regeneration delays caused by pests. Up to a certain limit, after an infestation has occurred, the mortality of individual trees causes a release effect on the residual stand. This release effect my partially compensate for other losses. This is particularly true of mixed stands where only one species is affected by the pest.

The methodology to calculate individual tree loss was also discussed. Losses in a period of time must be calculated relative to an estimate of what would have been the tree or stand growth had the pest not been active. This causes real problems. The interesting methodology developed at the Tree Ring Research Laboratory, as reviewed by Tom Swetnam, makes use of tree ring chronologies from unaffected trees or non-host trees, in similar sites (but avoiding release effect), to remove any reductions in growth caused by climatic conditions. I reviewed the methodology used at Pacific Forestry Centre which consists of using the growth trend of the tree prior to the infestation, to project and calculate unaffected DBH, height or volume. Non-pest effects are calculated by comparing projections on damaged and undamaged trees.

Finally, the group discussed the need to develop stand projection tools to enable the calculation of the losses to rotation age. Total losses will only be understood at harvest.

WORKSHOP: REARING PARASITOIDS AND PREDATORS
Moderator: Henry Moeck

This workshop was attended by 14 participants.

Insect rearing falls into two categories: a) partial rearing, in which immature insects are collected in the field and reared to the adult stage, and b) complete rearing, in which insects are reared from egg to adult, through more than one generation.

The objectives for rearing parasitoids and predators of forest insects are to provide specimens for biological studies, and for applied biological control through inoculative and inundative releases, or for export. The chief advantage of rearing insects vs. field collection of the desired life stage is the elimination of hyperparasites and diseases.

Many aspects of insect rearing were discussed, but not necessarily in the following order: I) stages in complete rearing: a) mating, particularly the difficulty of getting Lonchaea corticis (Diptera), a predator of Pissodes strobi, to mate in captivity, b) oviposition, c) rearing of larvae, d) pupation, and e) adult emergence; II) environmental requirements of insects: a) temperature, b) humidity and ventilation (a lot of discussion on this one), c) substrate for adults and immatures, and d) light requirements and control; III) troublesome insect characteristics: a) diapause and b) cannibalism; IV) food: a) natural - live or dead, and b) synthetic.

WORKSHOP: CALIBRATING PHEROMONES FOR DETECTION
Moderator: B. Staffan Lindgren
Participants: Thirty-nine early risers contributed to a stimulating session.

The moderator opened the workshop with a round of introductions and statement of interest by the participants. The interest statements included everything from general curiosity about pheromones to interest in the use of microencapsulated pheromones against forest pests. The level of modesty varied from John Borden's "We do a bit of pheromone research" to Tom Payne's "We do a whole lot!"

Gary Daterman was introduced as the expert on the workshop theme. Although he flinched at the "expert" label, he proceeded to present an excellent and stimulating talk on the work to develop a reliable monitoring system for early detection of outbreaks of the Douglas-fir tussock moth, Orgyia pseudotsugata. The system is based on inexpensive delta traps baited with PVC lures loaded with a low concentration of the pheromone. The active space of each trap is estimated at only a few meters. This means that the traps only sample the local population A yearly catch of 25 moths per trap was arbitrarily set as a threshold at which larval sampling would be needed to confirm whether outbreak conditions were developing. Five traps, 25 meters apart, were used in each plot to minimize variability due to trap placement. One plot was established for every 10 square miles. The program has been very successful to date. Gary estimated that out of 850-900 plots monitored in one year, 35 indicated outbreak. Out of these one plot actually had an outbreak. No outbreaks have occurred where the threshold has not been reached.

The presentation was followed by a lively discussion. John Wenz commented on the variability in catches, and regional differences for the thresholds. The discussion was expanded to include other Lepidoptera, such as the gypsy moth and the western spruce budworm. Tom Hofacker mentioned that (+)-disparlure is used for detection of gypsy moths in areas where this species is not established, whereas the less attractive racemic material is utilized to monitor population trends in a fashion similar to what was described for the tussock moth. Jon Sweeney noted the variation in catch between traps and between occasions in the same trap, as well as difficulties associated with the dispersion ability of the western spruce budworm.

The workshop was ended by a discussion on bark beetle monitoring. The moderator described the use of traps for monitoring the flight period of mountain pine beetles in order to minimize hauling restrictions on infested timber in the interior of B.C. He also mentioned the use of data from an ambrosia beetle mass trapping program as a basis for management decisions in dryland sorting areas. Ron Billings spoke on the need for monitoring programs for the southern pine beetle to complement hazard rating systems.

In conclusion, the discussion included monitoring rather than detection per se. The moderator felt that these two terms are essentially synonymous in the context of semiochemical applications depending on the objectives. The key to developing useful semiochemical-based monitoring is to clearly define the objectives of the research so that the final product provides the resource manager with useful and reliable data.

WORKSHOP: TOXICOLOGY
Moderator: Jackie Robertson
Participants: Bob Coulson, Felton Hastings, Tom Mather, Max McFadden, John McLean, Dave Overhaulser, Nancy Rappaport, and Paul Wood

After John McLean described a unique study of the relationship between arsenic trioxide present within western spruce budworm and mortality, discussions focussed on the development of an expert system for western forest defoliators by Bob Coulson and his Intelligence Engineer, and Jackie Robertson (domain expert). Tom Maher, Paul Wood, John McLean, and Dave Overhaulser discussed what they would like to see in such a system. Nancy Rappaport provided helpful comments; Max McFadden commented upon the value of this endeavor from the perspective of the Forest Service Washington office staff. Felton Hastings noted that the usual type of work that he and Jackie had been doing for years (going on decades!) was not what was needed to solve contemporary problems involving management of insects of forest trees. This was extremely interesting session since it resulted in the expansion of the Robertson-Coulson system to include defoliators in the Eastern United States and Canada. When the first version of the system is complete, Tom, Paul, Dave, and John have volunteered to test it.

WORKSHOP : EFFECTS OF WEATHER/CLIMATE ON INSECT POPULATIONS
Moderator : Alan J. Thomson
Participants : R. Silversides, W. Kemp

Major areas suggested for discussion were :

1) Analysis of outbreak start and collapse vs. analysis of population changes during outbreaks.
   - are different processes involved
   - can effects of weather differ at low and high population densities
2) Analyses to elucidate biological relationships vs. analyses to predict numbers or damage in the next year given the weather in this year.
   - hypothesis testing vs. prediction
3) Weather - based hazard indices.
4) Use of heat units to predict development.
   - effects of solar radiation
5) Phenology of insects and hosts.
   - may have different thresholds, starting dates and totals required
6) Evaluation of regional patterns.
   - determining regional boundaries
   - problems with transitional areas
7) Graphical vs. statistical methods.
   - problems when different factors can have similar effects
   - sequencing of weather events
   - includes problems associated with determining regional effects
   - includes problems associated with intraspecific variability in phenology
8) Dispersal.
   - determining sources and sinks
   - determining direction and distance
   - determining factors affecting probability of dispersal
9) Effects of mountainous terrain.
   - gradients of developmental rates
   - effects of solar radiation
   - channeling of dispersal
10) Effects of acid rain.
   - direct and indirect effects

R. Silversides gave a presentation on modern methods of collecting meteorological data, and W. Kemp described his analysis of climatic effects on western spruce budworm, to provide a case study.

Following these presentations, discussion centered mainly around a variety of graphical methods for studying weather patterns in relation to outbreak initiation and collapse.

WORKSHOP: CONDUCTING INSECT SURVEYS
Moderator: Terry Shore
Participants: Paul Wood, Bill White, Dave Gilbert

The discussion in the workshop was focussed on how to integrate forest insect survey data with the forest management process. Moderator Terry Shore gave an introduction to the subject, stating that while pest management and pest impact data affect almost every aspect of forest management the present level of integration is poor. The questions pest managers need to ask themselves, and answer are:

1. Who are the users of insect survey data?
2. Is this data readily accessible to the users and in a form that is useful to them?
3. Specifically, how is this data used to:
    a) update the inventory data base with depletions due to pests?
    b) advise the planning process of pest impacts in order to influence the decision-making process as to where, when and how much timber to cut?
    c) advise the silviculturists as to current or potential pest problems?
    d) advise the timber managers of harvesting or salvage opportunities which will minimize losses?

Paul Wood, Regional Pest Management Coordinator for the B.C. Ministry of Forests gave an overview of the planning process used in British Columbia and described how pest data is only, just recently, being considered in the process.

Bill White, entomologist with the Methods Application Group of the U.S.D.A. Forest Service, described their approach to the problem. He noted that, while there is a large amount of insect data available, most of it is not in a form that is useable by the forest managers. For example, many pest surveys record number of trees killed which is relatively useless for management purposes. Also, maps of pest infestations are bulky, difficult to store, access and interpret. He briefly described the Integrated Pest Impact Assessment System (IPIAS) that his group is developing. This consists of a user friendly computer system which will have access to the inventory data base, a geographic information system and pest, stand and socio-economic models.

Paul Wood then described how a recent task force on "The development of a pest management information system for B.C." identified some missing pest information components of the forest management process. Dave Gilbert of the Protection Branch, B.C. Ministry of Forests, is heading an implementation team that plans to remedy this situation. Discussion among the approximately 25 participants followed.

WORKSHOP: REARING PHYTOPHAGOUS INSECTS

Moderator: Don Scott

Participants: Ervin Kovacs, Laurie Friskie, Laura Merrill, Jill Lownsbery, Joe Fox, Bob Duncan, Mike Wagner, Jay Lexton

The workshop began, after an introduction by the moderator, with participants sharing various experiences and problems encountered in rearing phytophagous insects.

Difficulties ranged from inability to achieve colony establishment and multiple-generation survival of sawfly larvae to difficulty in maintaining a microsporidian-free laboratory colony of western spruce budworm, Choristoneura occidentalis, for pheromone studies. Specific rearing problems were discussed briefly but were beyond the scope of the workshop to resolve. Suggestions regarding evaluation of environmental conditions for rearing and sanitation measures were made, as were suggestions to contact specific colleagues at other agencies or institutions who have had related rearing experiences and could offer help. Other rearing activities varied from rearing beetle or weevil species associated with transmission of black stain fungus to rearing of broader taxonomic groups for identification purposes.

Scott pointed out that although our various work activities may require the rearing of systematically diverse groups of phytophagous forest insects, certain insect-rearing requirements are common to all, most important of which is contamination management through proper insectary sanitation and materials handling, especially for multiple-generation rearings.

To illustrate some of these requirements, Scott described the mass rearing of the Douglas-fir tussock moth, Orgyia pseudotsugata, at the Baculovirus Production Facility at Corvallis, Oregon, with which he had been formerly associated. The tussock moth mass-rearing effort was also used as a model defoliator mass-rearing system to illustrate the use of advanced technology, including automation in rearing phytophagous insects. Scott emphasized the importance of ingenuity and innovative thinking to mechanize difficult or tedious tasks in a mass-rearing program to increase efficiency, reduce cost, or ameliorate recurring monotonous rearing activities.

Joe Fox, University of California at Berkeley, described his novel system for rearing a bark beetle, the California five-spined ips (Ips paraconfusus) in conjunction with a study to evaluate the effects of various microorganism treatments on brood development and survival, using X-ray photography. Fresh phloem was stripped from pine billets, sterilized and placed within plastic cylinders, then I. paraconfusus eggs treated with selected microbes were introduced. These units were placed in plastic bags and followed over time until adults were produced.

The workshop was concluded by Scott stressing that we, as entomologists, are often inadequately trained in microbiology to be able to recognize disease or microbially-mediated deterioration in quality of insects.

Proper handling and sanitation practices to avoid microbial contamination of the insect colony are the critical factors that govern the success or failure of any insect-rearing program. Without careful attention to detect changes in quality, the health and vigor of a research insect stock could become compromised through microbial contamination, leading in some cases to erroneous research results where studies have made use of these compromised laboratory-reared insects.

WORKSHOP: ASSESSING THE EFFICACY OF PHEROMONE-BASED, PEST MANAGEMENT PROGRAMS

MODERATOR: John H. Borden

Fifty six persons were in attendance at this workshop.

PESTICIDE REGISTRATION

The chair opened preliminary discussion on the subject of registration of pheromones as pesticides. Opinions were expressed that although there is delay, the prospects for registration of pheromones (e.g. for the mountain pine beetle) in the USA are guardedly promising. The Ames Test is required for all materials. For use in traps, registration of pheromones is not required, but as tree baits or in disruption programs it is. In Canada any release of a material from a "device" or for use in pest surveys is exempt from registration. Otherwise, U.S. guidelines are usually followed in Canada, with extra paperwork superimposed. It was considered imperative that regulations not be breached due to frustrations with delays or dissatisfaction with the registration process.

EFFICACY OF PHEROMONE-BASED MANAGEMENT

Participants were asked to identify in writing the single most critical problem, which if solved, could lead to improvement in assessing the efficacy of three types of pheromone-based management programs for forest insect pests. Responses and the content of discussions are summarized below.

Detection and Survey

There was general agreement that it was impossible to separate these two applications of pheromones. For example, even if the objective were to assess the occurrence of a pest (i.e. detection), the numbers of insects caught in traps automatically yield quantitative data (i.e. survey). The single most important problem in using pheromone-baited traps for survey and detection was overwhelmingly identified as an inability to correlate trap catch data with actual population levels. Therefore, it is often impossible to determine what proportion of a population the traps are catching, and therefore to use trap catch data as predictors of subsequent, insect-caused damage. Thus the survey function is often lost. Other identified problems in assessing the efficacy of pheromone-based detection and survey programs were: a lack of data on cost-effectiveness, inadequate knowledge of the effect of environmental parameters on trap catches, lack of data on dispersal patterns of the target insects, poor knowledge of optimal trap spacing, and lack of complete identification of all behaviorally active chemicals for many species.

Disruption

The major problem in assessing the efficacy of pheromone-based disruption programs was identified as a lack of knowledge of spillover effects beyond the boundaries of a treated area. It was thus considered important to assess the impact of the treatment outside of the target area as well as within it. Other perceived problems in assessing whether or not a disruption program is effective were: lack of data on cost effectiveness, inadequate experimental evidence on the mode of action of disruptants, lack of data on damage reduction following treatment, and disagreement over the best measures of efficacy if damage cannot be assessed.

Mass Trapping and Trap Tree (or Crop) Techniques

It was agreed that these two techniques are really one, i.e. trap trees or trap crops are really "traps" used to mass trap or pest population. The major problem in assessing the efficacy of these programs was again related to population dynamics. Too often, it is impossible to determine the size of the population to be challenged. Therefore, one cannot assess how much a population has been reduced, and thus what the reduction in damage might be. Other identified problems in assessing the efficacy of mass trapping and trap tree (or crop) programs were: lack of data on cost effectiveness, the fact that leaving "control" (check) areas to compare with treated areas is incompatable with the objectives of forest management, lack of data on effective duration of treatments, and controversy over whether or not spillover infestations in mass trapping areas are beneficial or detrimental.

WORKSHOP: ESTIMATING MORTALITY RATES IN WILD POPULATIONS

MODERATOR: Ben Moody

PARTICIPANTS: 18 people attended

The discussion was opened with a round of introductions which included a statement of interests from the participants. Reasons given by the group for interest in estimating mortality rates included: efficacy of control operations, population dynamics and management guidelines, changes in host and parasites densities after release, population changes in cone and seed insects, aphid biology, western pine beetle flight stage, estimate of dispersals, and monitoring insect populations.

The moderator started the discussion with an example from the spruce budworm population sampling using the midcrown sampling method. This method very often proved unsatisfactory for survivorship curves and spray efficacy determination. The day to day variability gave pronounced zig-zag irregularity in the population curves making any calculations of reliable efficacy or mortality rates values unattainable.

With bark beetles, total beetle mortality is not equivalent to direct control. One important factor is difficulties in measuring adult mortality. Techniques are not very successful in catching beetle's over long distance dispersal and requires a large number of replications. A crude measure of adult flight mortality may be determined from an estimate of pre-adult emergence per unit area, the number of trees that can be infected plus FIDS estimates of beetle-killed trees minus unsuccessful attacks.

In general, we sample insect populations for abundance at two points in time and subtract to arrive at mortality. It was concluded that we have some knowledge of how to estimate mortality rates but we still have a way to go in perfecting the techniques.

Summary

Panel: Technology Transfer and Identifying Problems Requiring Research
Moderator: Bob DeBoo
Panelists: Dave Wood, Russ Cozens, Dave Graham, Craig Edward

Panelists, representing federal and provincial agencies and an American educational institution, presented a variety of experiences, views, and suggestions concerning the relationships between research activities and operational problems. Presentations included exposure of frustrations and pathways for funding pertinent academic endeavors, a Canadian federal initiative to market a bark removal-delimbing device to aid in bark beetle control, various perspectives on delineating R & D priorities and procedures, federal legislation being considered, the obvious need to directly connect research activities with operational concerns, the need to easily comprehend the implications of results and recommendations in publications, and the need to include users in the research planning process. Speakers stressed the importance of ranking research needs, wise utilization of scarce resources, and acknowledgement of the syndrome which often makes us "our own worst enemy."

A lively and wide-ranging discussion followed. All present considered technology transfer and integrated planning fundamental to successful forest insect pest management. Certain elements of Stark's (1982) paper were discussed and endorsed. These "lessons learned" included:

1. Technology transfer does not just happen, whether the research is from isolated projects or large structural programs. It must be planned from the beginning.
2. Technology transfer should be continuous.
3. Maximum effort in transfer of technology should be devoted to users, not the research community.
4. Fringe disciplines such as entomology and pathology must learn to present applications of their results in outlets appropriate to users and in an understandable form.
5. Although mass media are important in the early stages of technology transfer, the importance of personal contact throughout cannot be overemphasized.
6. Particular attention must be paid to the form and content of published material for users.
7. Award systems in research establishments should give appropriate weight to effective transfer of research results to users.
8. Users must be involved in developing research agendas and priority setting.

Reference: Stark, R.W. 1982. Applying research results from "fringe disciplines": lessons learned from pest management R D and A programs. In technology transfer in forestry, U.K. Forestry Comm. Bull. 61, Proc. IUFRO Conf., Edinburgh, pp. 32-37.

WORKSHOP: BARK BEETLES (ESP. HAZARD RATING)

Moderator: Gene Amman

Participants: Approximately 30

Stand hazard rating methods to assess bark beetle infestation potential are important to land managers, giving them time to schedule sale and harvest of susceptible stands prior to bark beetle outbreaks. The big question still remaining is, when will an outbreak occur? Hazard rating methods are of two general types, those defining thresholds and those defining specific stand characteristics of susceptibility.

For a hazard rating method to be used, the general opinion is that it must be simple and preferably utilize data obtained during stand examinations, because of cost. The more variables needed to be measured, other than for standard stand inventory procedures, the less likely a hazard rating method will be used.

Pete Lorio discussed some of the latest findings on southern pine beetle. During low levels of SPB, most infestations are associated with lightning struck trees in stands of high basal area. When these trees are large, they provide an abundant supply of food and good habitat for beetle production.

Skeeter Werner's group in Alaska found spruce beetle outbreaks were associated with slow growing spruce on south-facing slopes. Trees at the toe of the slope and those on north slopes were less likely to be infested. In addition, SB tended to infest slower growing trees.

Mountain pine beetle hazard rating methods now number seven for lodgepole pine: Culmination of mean and current annual increment; periodic growth ratio; crown competition; tree diameter, tree age and climatic suitability; periodic growth ratio divided by crown competition and a beetle production factor consisting of percent of basal area containing phloem 1/10-inch or thicker; quadratic mean diameter and number of annual rings in the last cm of diameter growth; grams of wood produced per m^2 of foliage.

As part of the Canada/U.S. MPB program, all hazard rating methods for MPB in lodgepole pine are being tested to determine the best method for a given geographic area. Several hundred stands have been measured on both sides of the border and data are presently being analyzed. Persons at Utah State University have analyzed U.S. data for tree losses in relation to Stand Density Index. There appears to be little relation to SDI except that losses are less at low and high SDI's. At the 1987 WFIWC, analysis of data should be complete for the Canada/U.S. MPB effort and all methods assessed.

Cone and Seed Insect Workshop

Michael I. Haverty, Moderator
U.S. Forest Service, Berkeley, CA

The purpose of this workshop was to discuss current research efforts and to outline future research needs. Mike Jenkins discussed his research on impact of western spruce budworm (WSBW) on seed production in Douglas-fir (D-f) seed tree and shelterwood cuts. Loss of cone buds is positively correlated with defoliation in the stand. Second instar WSBW overwinter in cone buds and selectively feed on recently-flushed female flowers, therefore, seed necessary for regeneration is not produced. WSBW larvae also "rain" down on seedlings that are produced and cause fatal defoliation. Jed Dewey described a study to increase the vigor of D-f trees so they might produce larger cone crops. Defoliation by WSBW is reduced by foliar sprays with B.t. Cone crops of these vigorous trees are then protected from WSBW by trunk-implants with acephate (Acecaps®). Roger Sandquist reported his efforts to protect foliage of Douglas-fir from WSBW with early and late acephate implants. As with Dewey's study, foliage protection will hopefully increase vigor for cone and scion production in individual, genetically-superior trees.

Gordon Miller continues pheromone research on Barbara colfaxiana and Contarinia oregonensis. With B. colfaxiana research is concentrated on optimizing trap height and pheromone release rates. With C. oregonensis pheromone identification is continuing. Toxicology research with Leptoglossus occidentalis will begin soon because this insect is responsible for up to 36% of Douglas-fir seed losses. Tim Schowalter described the impact of a newly-discovered cone pest: a weevil, Leptosoma lecontei. This insect feeds at night, causes conelet abortion and cone malformations. It was responsible for 10% of the seed losses at the Beaver Creek, D-f seed orchard.

Nancy Rappaport reported on experiments to evbaluate competition between D-f cone and seed insects. She will assess impact by selectively excluding pests (C. oregonensis, Megastigmus spermatrophus and Dioryctria abietivorella), singly and in combination, by placing pollination bags over flowers, conelets and cones during the oviposition period of each pest. Mike Wagner discussed insect impact on infrequent ponderosa pine (PP) cone crops in northern Arizona. The major pests were Conophthorus ponderosae and Cydia piperana. Dioryctria auranticella and Megastigmus albifrons also caused serious losses. Dioryctria appears to be successfully competing with Conophthorus for cone resources.

Mike Haverty outlined the PSW cone and seed insect research program. Priority tree species are D-f, blister rust resistant western white pine (BRR-WWP) and PP: D-f because of the large acreage of plantations and seed orchards, BRR-WWP because of high demand for the seed, and PP because of the multitude of seed zone x elevation combinations to be planted throughout the western U.S. The overall approach will be to develop integrated pest management recommendations. Active studies include: (1) Evaluation of registered and candidate insecticides in BRR-WWP seed orchards and D-f seed orchards and individual, superior trees, for optimum timing(s) and rate(s), (2) Pest management decision system for optimizing production in D-f seed orchards, (3) Chemosystematics of cone beetles, (4) Insect impact surveys in D-f, BRR-WWP, white fir and D-f + grand fir in Idaho, and (5) Annual variation and genetic component to insect impact in D-f seed orchards.

WORKSHOP: NURSERIES AND PLANTATIONS
Moderator: Dave Overhulser
Participants: Approximately 30 people attended this session with 16 individuals giving short presentations.

The goal of this workshop was participant exposure to the variety of studies under way on nursery and plantation insects. Everyone attending the session was invited to talk on their current interests and answer questions.

Much of the discussion on nursery pests focused on Lygus bug and sod webworms. Concern with Lygus damage to conifer nurseries in Oregon resulted in studies on insect distribution, stock susceptibility and control strategies. In British Columbia, insecticides were screened for Lygus control in container facilities. There was also a report on a sod webworm species girdling seedlings grown in styro block containers.

A strong contingent of participants from the southeast reported on a variety of plantation pests. In Texas, southern pine beetle was reported infesting loblolly pine plantations as young as 15 years old. Selection of resistant loblolly pine was being studied as a solution to Nantucket pine tip moth damage on severely infested sites. Other studies included work on seedling debarking weevils in slash pine and leaf cutting ants in young loblolly pine plantations.

Work on plantation pests in the West was dominated by reports concerning black stain, an insect vectored disease of Douglas-fir. In northern California and southern Oregon, studies were conducted on the timing of mechanical thinning operations to discourage colonization of stumps by black stain vectors. Reports were also presented on various trapping techniques for black stain vectors and the effects of chemical thinning on insect colonization of Douglas-fir. Work on the pheromone system of the ponderosa pine tip moth was continuing in southeastern Oregon. The problem of lodgepole terminal weevil damage in interior British Columbia was identified as a subject needing more research. Mention was also made of the spruce bud moth damage occurring in Alaska.

The variety of topics, study objectives, and research techniques discussed by the participants made for an interesting and informative session.

WORKSHOP: ASSESSMENT OF CURRENT WORK AND SUBJECT AREAS FOR FUTURE RESEARCH: DEFOLIATORS.

Moderator: Jon Sweeney
Participants: Nick Crookston, Bill Schaupp, Rene Alfaro, Imre Otvos, Roger Ryan, Dan Clair, Dave Leatherman, John Wenz, Tom Swetnam, Don Heppner, Rhonda Millikin, Phille Daur, Ningmei Chen, and Bob Duncan.

This workshop was approached from a management viewpoint with the following objectives:
1. To discuss current research on defoliators from different areas such as damage assessment, biological control, etc.
2. To identify areas requiring research in order to reduce defoliator impact.
3. To discuss how and where such research should be conducted.

Nick Crookston began by presenting a brief summary of the western spruce budworm(WSBW) / Stand prognosis model and identified four areas in need of further work in order to have the model more closely simulate reality:
a) Outbreak prediction There is no clear understanding of the factors and conditions which lead to budworm outbreaks so it is difficult to quantify and incorporate outbreak probabilities into the model.
b) Damage assessment We lack quantitative data on budworm induced growth loss, top-kill, and mortality at different intensities of infestations and on different kinds of sites. Most of the impact estimates incorporated into the model comes from the Railroad Creek study in B.C., in which the infestation levels were quite high. Ferguson is currently quantifying the impact of WSBW defoliation over a range of infestation levels, stand and site characteristics but the study is in danger of losing funding before completion.
c) Adult dispersal The model's simulation of adult dispersal at present is a best guess;there is very little data.
d) Technology transfer We need to encourage the field foresters and managers to use the model and evaluate its predictions and to incorporate the model into their decision making process.

Imre Otvos initiated some discussion about the value and end use of models. Do we rely on them too heavily? Are they useful for pointing out areas of necessary research? Should they be approached theoretically or based on empirical data collected from a large variety of sites and stands?
Nick Crookston remarked that while models are valuable tools for both research and resource management, they should not be stressed to the point that other areas of research are neglected. Roger Ryan commented that even if a model provided the best possible representation of budworm-forest dynamics, based on current and historical data, there is always the risk that unforeseen changes in the environment,

markets, etc. could throw the models predictive capability out the window.

Rene Alfaro summarized some current work at P.F.C., relating the amount of top-kill and tree mortality to the number of years of WSBW defoliation (as detected by aerial surveys)in 60 plots over a range of stand and site types. The data was highly variable but significant relationships were found. Mortality was up to 30% of the stand volume on steep slopes while stands on flatter terrain suffered little mortality but still had significant growth reduction. Average mortality was about 5% in dominant trees but was up to 10-15% in stressed trees. Rene also mentioned that they have 6 years of data collected on damage to sprayed vs. unsprayed WSBW infestations but it is awaiting analysis. Rene stressed that while we may get some feeling for the effects of defoliation on growth rate and stand mortality we really do not know for sure what that growth loss will mean at the end of a rotation; eg. what are the possibilities of rebounding growth rates?

Discussion then turned towards how and where we, as entomologists, should direct our research efforts. Should we have the field forester point us in the right direction? Nick Crookston commented that it's not as simple as doing what the foresters think is best because they may not have the best approach either. However, Nick, echoing the sentiments of Al Stage(not present), feels that foresters should be consulted from the outset in order to better facilitate technology transfer in the long run.

Should we be fighting fires(ie. letting the current outbreak direct our efforts) or should we be taking a long term look at a particular insect population? Most everyone agreed that it is precisely the low population densities that need studying, especially in terms of the natural biological control factors at work. Bill Schaupp commented that the complement of predators and parasites may be very different depending on the hosts' population density and that if we are interested in trying to manage our resources so as to keep pest populations at near endemic levels , then we must begin to understand how they operate at those levels.

While there was general agreement that long-term population studies were desirable there was also a few reservations on their practicality:
1) It's hard to get funding for work on a currently low profile pest when other pests are eating the forests and getting all the attention,
2) The methodology for sampling low population densities is difficult and expensive.

Notwithstanding these difficulties, Nick Crookston is optimistic that we can get answers to these questions if we

are willing and committed. Perhaps the longer-term studies can be handled by the academics who are under less pressure to "fight fires". Bill Schaupp pointed out that graduate students are unable to undertake long-term projects due to the time constraints of a graduate program.

On the subject of population monitoring, Jon Sweeney said he would like to see permanent plots established in WSBW susceptible areas and look at the relationships between pheromone trap catches, larval densities and defoliation levels from year to year. The "threshold level" of trap catch would have to be calibrated for different areas because the relationship between trap catch and larval density appears to vary a great deal depending on trap location. In contrast, Imre Otvos pointed out that for the Douglas-fir tussock moth, the threshold level of pheromone trap catch was fairly consistent over different areas.

On research methods, Nick Crookston said that we could improve statistical sampling methods in some studies. For example, in hazard rating studies we look at infested areas and rate site characteristics as to high, low, or medium but we often do not look at similar sites in areas with no damage. Imre Otvos pointed out that the best laid statistical plans may have to be altered once under time/money constraints in the field. Nick agreed but said better techniques, such as stratified random sampling, could be used to improve certain studies.

SUMMARY

1. There are many unanswered questions in several areas of defoliator research, but particularly in impact assessment, population dynamics and outbreak prediction (no surprises here).
2. If we are ultimately striving to manage our resources to reduce the probability of pest outbreaks then we have to start looking at what's happening at the low population levels so we can begin to understand how the systems function. We also face the reality that funding is difficult for pests which are not currently getting press.
3. We need better cooperation between researchers and field foresters from the start of any research project in order to facilitate technology transfer.

PANEL: FEASIBILITY OF DIRECT CONTROL
Moderator: Peter M. Hall
Panelists: R. Cozens, D. Holland,
J. Churcher, M. Hulme

Direct control of forest insect pests has a long history of application and controversy. Direct control, that is, the application of a treatment or combination of treatments to reduce an insect population to a level where the damage caused is economically tolerable, is the traditional approach in the management of forest insect pests. Treatments such as the aerial application of insecticides are directed at the insect itself and do not alter the stand conditions which may have contributed to the insect outbreak. Direct control treatments may not be long-term solutions; rather, they act as interim "band-aid" solutions which will preserve resource values while more long-term management solutions are implemented.

R. Cozens has been extensively involved with the bark beetle program in British Columbia and presented some of the rationale behind the current direct control program for mountain pine beetle. The application of direct control procedures such as felling and burning infested trees and harvesting of infested blocks has been judged to be effective when applied under the correct circumstances:

1) it must be considered as part of a co-ordinated forest management plan;
2) there must be specific goals attached to a direct control project. When a program or portion of a program is not meeting the objectives, consideration must be given to abandoning further effort and redirecting efforts to where they will be more successful;
3) it is a "stop-gap" measure until the stand can be accessed and long-term management implemented;
4) a total, complete, long-term commitment must be made once a project is undertaken; and,
5) detection in the early stages is important for effective treatment.

Further, the use of stand hazard and risk rating systems should be implemented. These, coupled with the use of semio-chemicals make direct control programs for bark beetles viable.

D. Holland related U.S. experiences with direct control of mountain pine beetle. Mountain pine beetle outbreaks have occurred periodically in suitable stands since the first recorded outbreak in 1902. A variety of strategies have been employed to "control" the beetle infestations and preserve the resource from the impacts of the beetle. The majority of the strategies entailed treatment of individual trees. The large scale

control efforts of the 1950's, and 1960's failed to stop the infestations. In the 1970's, the emphasis changed from individual tree control to individual tree protection. However, although the use of chemicals to protect high-value trees from attack by mountain pine beetle has proven effective, it is costly and impractical on a forest wide basis. Management of mountain pine beetle is currently considered feasible only through management strategies which integrate the biology and population dynamics of the beetle with the successional role of the vegetation in the environment.

The objectives for manipulating pests should be to utilize the natural ecological processes to advantage. The management system developed must promote stand structures, compositions, and conditions that minimize pest damage. The only long-term solution to bark beetles is through silvicultural prescriptions designed to enhance vegetal diversity, taking into account that bark beetles act as regulators of unmanaged forests.

Moving eastward, bark beetles decline as a problem. However, this is more than made up for by recurrent outbreaks of a variety of defoliators such as spruce budworm and gypsy moth. J. Churcher discussed the application of direct control to such pests. The approach taken in Ontario is not to "control" defoliators; rather, the approach is to control or limit the extent of their damage. Operations address three levels of control: 1) epicentre suppression on small, new infestions; 2) outbreak containment on older expanding infestations; and 3) foliage protection on very large epidemics. In the latter case, the intent is not to kill insects; the goal is to keep trees relatively green and alive.

Only specific stands merit the aerial application of insecticides. Commercially operable forests (those stands which are proposed for harvest within ten years) comprise the first category of candidate spray blocks. Stands that have a management value (seed procurement areas, intensively managed plantations), an aesthetic value (provincial parks, recreation areas), or an ecological value (fish or wildlife habitat) are the second category of candidates that may be sprayed.

This approach has worked successfully in Ontario for a number of years. After a complete review in 1985, the basic premises of the policy were left untouched. Based on the results of previous year's protection programs, the policy works. Although it may not be feasible to "control" defoliators, there are at least the knowledge and tools available to limit the extent of their damage.

The applications of biological control were discussed by M. Hulme. The feasibility of using living organisms for control of forest insect pests has three main aspects: technical, economic, and social. Technically, biological control shows great promise. Of twenty-one targeted pests in the past decade, fourteen were successfully controlled by reducing tree damage to tolerable levels. Seven of these resulted in "permanent" control through the introduction of parasitoids. Other notable examples are the applications of B.t. for a variety of pests and the use of the Douglas-fir tussock moth NPV. Economically, although few studies have been done, it appears that biological control can be implemented at lower

long-term cost than other control options. This may be a result of the reduced need for periodic repeat treatments. Biological control also is socially acceptable. With increasing controverys over the use of traditional chemical insecticides, the application of biological control agents (especially B.t. and viruses) becomes a more and more attractive alternative.

Direct control of forest insect pests will always remain a useful tool to forest managers. Unforeseen problems will continue to arise which will require immediate solutions. Prime examples are insects such as budworms, tussock moth, black army cutworm; and cone and seed pests. Further, long-term silvicultural prescriptions cannot foresee all potential problems and there will be a need to reduce losses when these prescriptions have been inadequate for prevention.

WORK SHOP: BIOLOGICAL CONTROL USING PARASITOIDS AND PREDATORS

Moderator: Imre S. Otvos

Participants: H. Barclay, B. Duncan, G. Edwards, D. Elliot, J. Foltz, J. Harris, L. Humble, M. Hulme, J. Moser, R. Ryan, S. Salem, J. Schenk, A. Thomson, and S. Tunnock

It was first discussed what is a successful biocontrol, and how to appraise it. Percent parasitism alone was not considered to be enough. Also, measuring host density or reductions in host damage does not necessarily prove that it was the control effort and not some natural phenomenon that reduced pest numbers, unless adequate "control" plots were also established. It was suggested that a life table approach would be good, if one could afford to do it, otherwise increasing parasitism, decreasing host levels and damage "must do".

Control may be either self perpetuating (successful "classical biocontrol") or need periodic "renewals" (like B.t.). There was some discussion whether B.t. should be classified as biocontrol agent or grouped with chemical insecticides. In spite of its annual application requirement to be effective the use of B.t. was considered biocontrol in the broad sense.

Biocontrol can be used against both introduced and native pests. Examples of local success of biocontrol are: white flies in green houses, winter moth and Douglas-fir tussock moth.

The question whether parasitoids are generally more effective than predators was discussed. Predators are general feeders and consequently are able to find alternate prey when the pest insect has been reduced to low numbers. The reason for fewer examples of successful biocontrol with predators than parasites may be because fewer predators have been tried.

On the question of multiple vs. single species introduction the group favored multiple introduction and letting the introduced parasitod/predator complex "sort themselves out". Probably none of the introduced natural insect enemies may be harmful to biocontrol attempts. However, there was concern for introducing other animals and plant (weed) eating insects. Parasitoids and some predator species are usually quite host specific, and that all that might be harmed would be some other pest insects. Usually, total parasitism was still high in spite of hyperparasitism. An interesting exception (but not with introduced species) was the case of the territorial robber fly which actively attacked other insects, including parasitoids and predators, which approached the grasshoppers on which the robber fly itself fed.

Modelling techniques were also discussed. It was recognized that "real answers" will only be available if real data were plugged into models. Nevertheless it was felt that modelling could help in making decisions as to where further research is needed and in predicting the results of various levels of parasitism and predation. However, there were strong feelings that modelling cannot be used to predict the out come of multiple introductions.

The question whether the best parasitoid for controlling larch casebearer could have been picked before release Ryan replied that it would have been difficult, if not impossible, to predict but Agathis pumila was an obvious place to start. With the winter moth it was felt that the two successful parasitoids, out of the six introduced into Nova Scotia, would not have been selected for introduction if the decision has been based on theoretical modelling and/on "gut" feeling.

Follow up work should be done on introductions previously considered to be unsuccessful, e.g. predator releases against wolly adelgid. An example for such work is the tachinid, Winthemia occidentis introduced against the eastern hemlock looper into Newfoundland from B.C. in the early 1950's. Initial attempts to demonstrate the establishment of this parasitoid were negative. Only later efforts in the 1970's demonstrated that the parasitoid was established and became an important component of the control complex.

WORKSHOP: CHEMICAL CONTROL - BARK BEETLES
Moderator: Patrick J. Shea

Participants: About nineteen participants representing the Canadian Forest Service, USDA/Forest Service (several Research Stations and western Regions), Provincial and State Forestry Agencies, and Canadian and U.S. Universities attended the workshop.

Following a brief introduction concerning the purpose of the workshop, the moderator reviewed his research on the use of "pine oils" to protect individual trees from attack by bark beetles. Results of last year's tests to protect individual lodgepole pine and white spruce from attack by mountain pine beetle and spruce, respectively, were presented. Four identical formulations of "pine oils" were tested in both Alaska and Montana with somewhat different results. In Alaska all test formulations showed some effect in preventing mass attack by spruce beetle during the initial flight period. However, evaluations after completion of the flight period indicate that the formulations failed to prevent numerous successful attacks. In Montana about 60+% of the test trees treated with 2 of the 4 test formulations were protected from mass attack by mountain pine beetle. This represents the highest level of protection after two years of testing in the Montana area. Safranik reported on a limited effort at testing for area effects with Celetex boards impregnated with a "pine oil" formulation in interior British Columbia. The purpose was to assess whether attacking mountain pine beetles could be kept out of a small stand of lodgepole pine. The results were very inconclusive. Mike Jenkins, Utah State University, reported on another area effect test conducted in a mountain pine beetle infestation in Utah. Individual lodgepole pine were treated in a grid design on 5 acre plots with Norpine 65P. His evaluation could detect no area effect.

There was considerable discussion concerning the conflicting results over the past few years on the effectiveness of "pine oils" for protecting individual trees from attack by bark beetles. Factors such as attack pressure, differential response related to geographical variation in insect populations, and variation in "pine oil" formulations were put forward as possible causes for the mixed results.

WORKSHOP: CONTROL TECHNIQUES - B.t. AND PATHOGENS
Moderator: Joe Churcher
Participants: Temple Bowen, Rhonda Miliken, Jed Dewey, Bruce Hostetler, Dave Leatherman, John Dale, Tom Maher, Tony Smith, R. C. Ostrowski, Don Heppner, Jerry Carlson

Participants in this workshop had previous experience with and/or particular interest in the biological insecticide Bacillus thuringiensis (B.t.), the Douglas-fir tussock moth nuclear polyhedrosis virus and fungal pathogens effecting various insect species. The majority of the time allotted was devoted to aspects of the operational use of B.t.

Initial questions revolved around the control objectives which B.t. could reasonably be expected to achieve, i.e. foliage protection vs. population reduction and eradication. Most people had used B.t. in an effort to limit the damage caused by defoliating insects and were satisfied with the results. Bruce Hostetler described the 1985 gypsy moth eradication program in Oregon which achieved its objective of population reduction in most areas, but fell short of complete eradication of the pest in Lane County. A follow-up program is tentatively scheduled for 1986.

The question of the residual activity of B.t. was posed. While work is presently being conducted in attempts to incorporate stickers and ultra violet light protectants in commercial B.t. formulations, the problems of delaying the loss of the product by 1) rain and 2) degradation by sunlight are still two of the limiting parameters haunting this insecticide. It is believed that continued use of B.t. in western North America will resolve these logistical problems which currently exist in that part of the continent.

The majority of the discussion in this workshop was directed towards public perceptions of chemical and non-chemical insecticides, the relative environmental and health hazards posed by each and the social and political pressures placed on forest and forest pest managers to use only non-chemical direct control techniques. It was expressed that the major danger to be encountered with the removal of all chemical insecticide tools would be the eventual reliance on alimited number of products. "Putting all your eggs in one basket" was not deemed to be a professionally sound position in which to be placed. However, such restraints and restrictions can have positive ramifications, as one participant pointed out. If we as managers have few, if any, short term control options available, then we are forced to maximize the utilization of other available techniques, i.e. cultural methods, biotechnology and intensive management. In short, we must place increased effort in practising "integrated pest management". In the meantime, as our hands continue to be tied tighter by public perceptions, and the decisions regarding forest management continue to be based on socio-political as well as technical grounds, we must do the best professional job possible with whatever options we do have available. After all, we entomologists and pest managers are much like the pests we study; we are a pretty adaptive and resilient bunch.

Workshop: Behavior-Modifying Chemicals for Bark Beetles

Moderator: Ken Gibson

Participants: Steve Burke, John Borden, Staffan Lindgren, and Ed Holsten presented information or results from projects in which they are currently engaged. Nineteen others representing various organizations and agencies attended and contributed to the success of the workshop.

The use of behavior-modifying chemicals for bark beetle population manipulation has only recently become a viable management alternative. The importance of pheromones--chemical "messengers"-- in the population dynamics of several important insect species has been realized for nearly 2 decades. Recently, the proper mix of beetle-produced pheromones and host-produced monoterpenes useful as a tool in combating bark beetle depredations has been identified.

John Borden, Simon Fraser University, described his research which led to the identification of the semiochemical complex important in the management of mountain pine beetle populations. The combination of the female-produced trans-verbenol, the male-produced exo-brevicomin, and the lodgepole pine monoterpene, myrcene, has proven to be a powerful mountain pine beetle attractant. Used as "baits," they effectively turn a living lodgepole pine (of an appropriately large diameter) into a standing "trap tree." When used in a hanging funnel trap format, the combination shows promise as a survey or population monitoring tool. Similar complexes of chemicals have also been identified for Douglas-fir beetle, spruce beetle, several species of Ips, and some ambrosia beetle species. Strategies for the use of semiochemicals to manipulate bark beetle populations were also described.

Steve Burke and Staffan Lindgren of PheroTech, Inc., Vancouver, British Columbia, identified management situations where tree baits work and where they do not. Living, standing trees that are baited will act to concentrate and contain infestations--a valuable tactic where trees cannot be immediately removed or where baits are used in conjunction with pesticides. Tree baits will not, however, compete with felled timber or trap trees. They are of little use when attempting to attract beetles to downed material. Research to make these valuable chemical tools more readily available, as well as economically and biologically efficient, is ongoing. Tree baits, Lindgren funnel traps, and bubble-cap releasers are but a few of the innovative semiochemical dispensers currently available or planned for in the near future.

In the early 1970's, methylcyclohexanone (MCH) was identified as an important anti-aggregation pheromone for Douglas-fir beetle and spruce beetle. Since then, pilot control and fully operational projects have shown the value of using this pheromone in a controlled-release dispenser to protect inaccessible blowdown from attack. Using that strategy, managers have prevented population buildups in downed material, and ultimately protected surrounding standing timber. An operational project conducted in 1984 in northern Idaho as a cooperative effort between Idaho Department of Lands and Forest Pest Management, Northern Region, was described. Attacks in treated blowdown were reduced by nearly 96 percent when compared to similar blowdown in untreated areas. Ed Holsten, Forest Pest Management, Alaska, described some of their efforts to protect downed spruce from spruce beetle attack using both macromelt plastic pellets and bubble-cap dispensers. Their results have not been as good; however, they believe the problem is the MCH elution rate in their cold environment rather than the basic strategy itself.

Finally, some of the early testing with pine oil repellents for bark beetles was discussed. Though not a pheromone, but rather a by-product of the pulping process, pine oil is a "behavior-modifying chemical" in that it has been shown to be an effective mountain pine beetle repellent in some situations. The participants agreed that while pine oil can protect individual trees from attack, it is not likely to be effective in protecting stands from infestation. Much testing remains before pine oil might be registered for use. Still, the potential exists for it to be a more environmentally acceptable alternative to preventive insecticidal sprays in some cases.

Although some obstacles remain before the operational use of behavior-modifying chemicals will be fully authorized in the United States, all agreed that their future appears bright. Implementation of these naturally occurring compounds will enable pest managers to turn the "beetle's ecological advantage" into a handicap which may help tip the balance in our favor.

THIRTY-SEVENTH WESTERN FOREST INSECT WORK CONFERENCE

Minutes of the Final Business Meeting
Victoria, British Columbia, March 6, 1986

Chairperson McLean called the meeting to order at 10:30 a.m.

The minutes of the Initial Business Meeting and the Treasurer's Report as of March 6, 1986 were read and approved.

The motion to change the name of the WFIWC to the Western Forest Insect Workshop was discussed at great length by the membership. A vote from the floor was taken and a majority of the membership voted against the motion to change the name.

Peter Hall, chairperson of the Commercial Displays Committee offered to seek out members opinions on the issue of commercial displays and support.

Dave Holland, chairperson of the Ethical Practices Committee reported that no member qualified for the award this year. A notice of motion "that the Ethical Practices Award be retired by the History Committee with all the due reverence and honor as an award that has served the membership well for a period of time when it was appropriate", was presented to the membership. The motion was accepted by the membership, and Dave read a poem "On Retiring The Ethical Practices Award". A copy of this poem is included in the Proceedings.

Nick Crookston reported that he will be involved in forming an Honor Award (Special Awards) Committee to replace the Ethical Practices Committee.

Dave Overhulser of the Resolutions Committee proposed that a special thanks be given to the Empress Hotel for its hospitality, the British Columbia Forest Service for providing the social mixer, Gordon Miller and Peter Hall for an interesting program and a job well done, and Allan Van Sickle and his local committee for the smooth running of the meeting and the social activities.

Ron Stark presented the candidates selected by the Nominating Committee: Dick Schmitz, chairperson and Terry Shore, new councilor. The nominees were elected by acclamation of the general membership.

Dave Holland invited members to the 1987 WFIWC meeting at Park City, Utah, March 2-5.

Chairperson McLean called for invitations for the 1988 WFIWC. Arizonia/New Mexico was suggested for the 1988 meeting.

Dick Schmitz accepted the gravel of office as chairperson from John McLean.

The meeting was adjourned at 11:35 a.m.

"ON RETIRING THE ETHICAL PRACTICES AWARD"

David G. Holland
March 6, 1986
Victoria, B.C.

As we sit and reflect on the days of the past,
and realize the present becomes the future too fast.

We remember the fun we had with a sigh,
and think of past times with a tear in our eye.

Let us again reminisce of days of yore,
when members would seek the Barroom door.

It seems those truly liberated souls,
tried hard to visit every "watering hole".

In meetings they debated to exhilarating heights,
and following the workshops they debauched all nite.

And we watched in amazement, this strange membership,
of the most crazed and deviant showmanship.

Some cried " Honor those crazy bug-loving specialists",
with an award that merits their raunchiness.

So such was the Ethical Practices Award,
sanctioned as an honor by the Executive Board.

To those blood-shot eyes on the final morn,
was presented the Spinaker of Tempest Storm.

Let us honor a few from days gone by,
and review their exploits praised so high.

It was '53 when the award was first born,
and most appropriately awarded to Jim "Bum Tittie" Kinghorn.

Cal "Tempest" Massey in '54 did bequest,
the original "trappings" of Tempest Storm from the El Rey Burlesque.

Then hail to Walt Cole, our only three time winner,
who once moved a piano seven floors after dinner.

Ah yes, there was Werner, Holland, Mitchell, Silver and Wright,
who won the award twice each for their deviant plight.

And let's not forget "Bawdy Broad" Stock and Maxine Moyer,
our only two, honored, female voyeurs.

But alas, the list of the thirt-six infamous is long,
let's commit it to memory, and the deeds will live on.

As we smile and remember our fun-loving past,
we realize that the times are a-changing alas.

The deeds and behavior that first gave rise to this award,
in the annals of debauchery, are no longer scored.

So let us drink tonite to what our memories aford,
and to the archives retire the Ethical Practices Award.

TREASURER'S REPORT

Thirty-seventh Western Forest Insect Work Conference
Victoria, British Columbia, March 6, 1985

Balance on hand March 3, 1986	(+)	$ 2,374.23 Can.
Expenses:		
Banquet - Rent of Ballroom	(-)	250.00
- Goldsteam Catering Ltd	(-)	2,375.00
Bus Charter	(-)	400.00
Hotel - photo-copying, pointer, coffee, etc	(-)	574.00
Receipt-books	(-)	3.69
Photo copying	(-)	1.00
Coffee and cookies	(-)	75.00
Income:		
Registration (143 + 22 spouses)	(+)	6,831.00
Sale of Proceedings	(+)	24.00
Balance on hand March 6, 1986	(+)	$ 5,550.54 Can.

CONSTITUTION
OF
WESTERN FOREST INSECT WORK CONFERENCE

Article I Name

The name of this organization shall be the Western Forest Insect Work Conference.

Article II Objects

The objects of this organization are (1) to advance the science and practice of forest entomology, (2) to provide a medium of exchange of professional thought, and (3) to serve as a clearing house for technical information on forest insect problems of the western United States and Canada.

Article III Membership

Membership in this organization shall consist of forest entomologists and others interested in the field of professional forest entomology. Official members shall be those who pay registration fees.

Article IV Officers and Duties

The officers of this organization shall be:

(1) A Chairman to act for a period of two meetings, whose duties shall be to call and preside at meetings and to provide leadership in carrying out other functions of this organization.

(2) An Immediate Past Chairman, who shall assume office immediately upon retiring as Chairman without further election; whose duties shall be to fill the chair at any meeting in the absence of the Chairman; to act until the election of a new Chairman.

(3) A Secretary-Treasurer to act for a period of two meetings whose duties shall be to keep a record of membership, business transacted by the organization, funds collected and disbursed and to send out notices and reports. The Secretary-Treasurer is charged with the responsibility of preparing the proceedings for the conference in which his term of office is terminated (amended Feb. 28, 1967, Las Vegas, Nevada).

(4) An Executive Committee of six members, consisting of Chairman, Immediate Past Chairman, Secretary-Treasurer, and three Counsellors elected from the membership. Terms of office for the three Counsellors shall be staggered and for a period of three meetings each. The duties of this Committee shall be to carry out actions authorized by the Conference; to authorize expenditures of funds, and to establish policies and procedures for the purpose of carrying out the functions of the organization. The Conference registration fee will be set by the local Arrangements Committee in consultation with the Secretary-Treasurer and Chairman (amended March 4, 1965, Denver, Colorado).

The officers shall be elected at the Annual Meeting. Their periods of office shall begin at the conclusion of the meeting of their election.

The Chairman shall have the power to appoint members to fill vacancies on the Executive Committee occurring between meetings. The appointment to stand until the conclusion of the next general meeting.

It is the responsibility of a Counsellor, should he be unable to attend an executive meeting, to appoint an alternate to attend the executive meeting and to advise the Chairman in writing accordingly. The alternate shall have full voting privileges at the meeting to which he is designated.

Article V Meetings

The objectives of this organization may be reached by holding of at least an annual conference and such other meetings as the Chairman, with the consent of the Executive Committee, may call. The place and date of the annual shall be determined by the Executive Committee after considering any action or recommendation of the conference as a whole. The Secretary-General shall advise members of the date and place of meetings at least three months in advance.

Article VI Proceedings

A record of proceedings of conference shall be maintained and copies provided to members in such form as may be decided as appropriate and feasible by the Executive Committee.

Article VII Amendments

Amendments to the Constitution may be made by a two-thirds vote of the total conference membership attending any annual meeting.

Prepared by Richard Washburn
March 20, 1969.

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